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ABSTRACT

Each year more lives are lost due to floods than due to the next 18 natural disasters put together. The element of human choice makes the study of floods and droughts an opportunity for decision making experiences for students. This document contains information and activities designed to be used in correlation with a science unit or as a supplement to an elementary science curriculum. The lessons are arranged sequentially, but activities can be extended or omitted according to student interests and abilities. Questions are included that require students to: (1) look for cause and effect; (2) make predictions based on information in the reading selections; and (3) to draw conclusions supported by the evidence presented. Extension sections are included to challenge students to pursue topics and free informational material according to their interests, talents, and capabilities. A glossary and an answer key for the activities are included. (TW)

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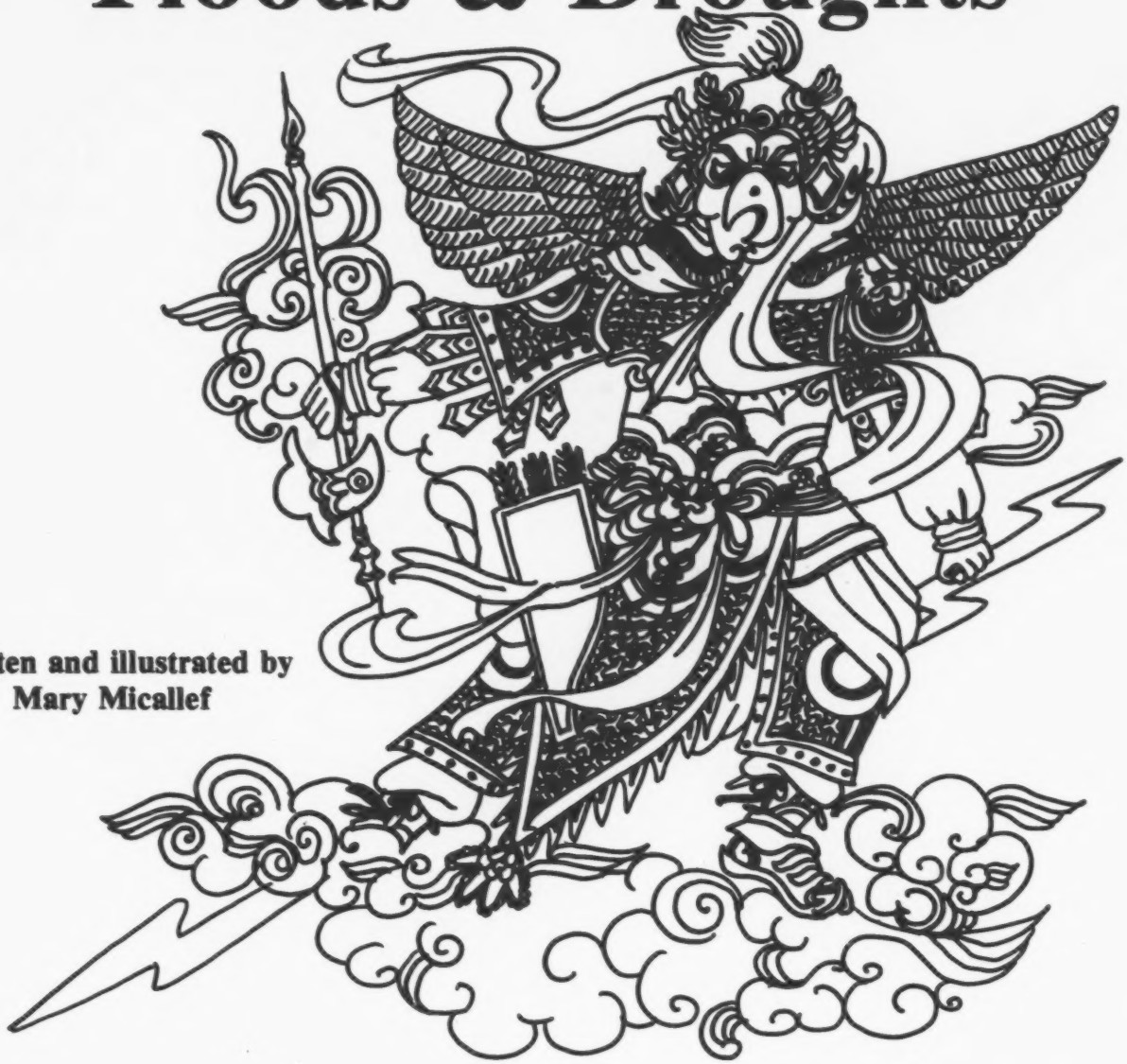
Floods & Droughts



Written and illustrated by
Mary Micallef

An adaptation of the ancient Chinese weather god, Lei Chen Tzu, as he heralds the approach of a thunderstorm

Cover by Phil Brevick

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With special thanks to Ruth Deery, who originated the idea for this series and was a constant source of support and materials, and to the teachers and students at Bitburg Middle School, Bitburg, Germany, who provided art tables, critiques, and zwiebelkuchen!

A WORD TO THE TEACHER

OVERVIEW

Floods & Droughts is a unit of lessons and activities that provides students with a basic understanding of the causes and consequences of two natural disasters. Children learn about the mythological and historical aspects of floods and droughts, types of floods, flood forecasting systems, and flood safety rules.

Each year, more lives are lost in floods than in the next eighteen natural disasters together. Unlike the other catastrophes, however, people themselves cause many of the most devastating floods. In an effort to harness water power and to control the flow of water, human beings interfere with the ecological balance of the water cycle. By building cities on floodplains and reclaiming wetlands for farms, people invite disaster.

The element of human choice makes the study of floods and droughts an exciting scientific adventure while it provides opportunities for decision-making experiences. Students gain important insight into their own role in planning for future ecological-technological balance. People can most effectively implement change if they know about wetland conservation and floodplain management. It is important to have a firm base of information about what can be done, what has been done, and how alternate plans have succeeded.

FORMAT

Information and activities in this book are designed for classroom teachers to be used in correlation with a science unit or as a supplement to a science curriculum. It can be adapted to meet each teacher's specific classroom needs and unique teaching style. The units are arranged sequentially, but activities can be extended or omitted according to student interests and abilities.

With an emphasis on scientific reading skills, most lessons are followed by three multiple choice questions. The questions encourage comprehension, evaluation, and application skills by requiring students to look for cause and effect, to make predictions based on information in the selection, and to draw conclusions supported by the evidence presented. Classroom discussion of these questions enables students to review and extend what they have learned in the lesson. An answer key is on page 44.

EXTENSION

A. **Read to Find Out** sections challenge students to pursue topics according to their own interests, talents, and capabilities. If children are encouraged to share what they have learned on a daily basis, their classmates will also benefit from the enrichment. A bulletin board of student posters, book recommendations, incredible facts, drawings, and maps is an excellent way to enable children to learn from each other.

Most books about mythology are found in libraries under Dewey Decimal 291. Many books about floods and droughts are in the 551 section. Since information is so rapidly updated, the books since 1973 are probably most useful. Current findings can be located in the *Readers' Guide to Periodical Literature*. Fictional flood stories like *Tattie's River Journey* by Shirley Rousseau Murphy help make the studies come alive!

B. At the end of this book is a list of thirty-nine places where children can write for additional information about floods and droughts. As an initial activity, each child in the class could write to a different source. Facts and figures will begin rolling in just as students need the extra boost! Provide a reading corner for sharing booklets, posters, and letters.

The bibliography on page 44 is just a starting point of background and supplementary books for this unit. Add to it! Encourage students to share books and magazines. The classroom library can provide a wealth of answers to extraordinary questions as students become involved with *Floods & Droughts*.

C. As with any relevant topic, children who keep notebooks or journals of information, quotes, resources, notes, and questions will have their own permanent summary of the subject that personalizes and perserves their study. Copies of the Chinese weather god on the title page of this book might make attractive covers for children's notebooks.

D. Some parts of *Floods & Droughts* are specifically designed to stimulate children's interests. "Some Properties of Water" (page 2) might be presented as a whole class discussion with children gathered in a listening circle (away from the listening barriers of desks and distance!) on the floor near the teacher. Brainstorming is welcomed! Children have an opportunity to get excited about what's coming up. "Working for Environmental Changes" (page 37) is another good class discussion activity.

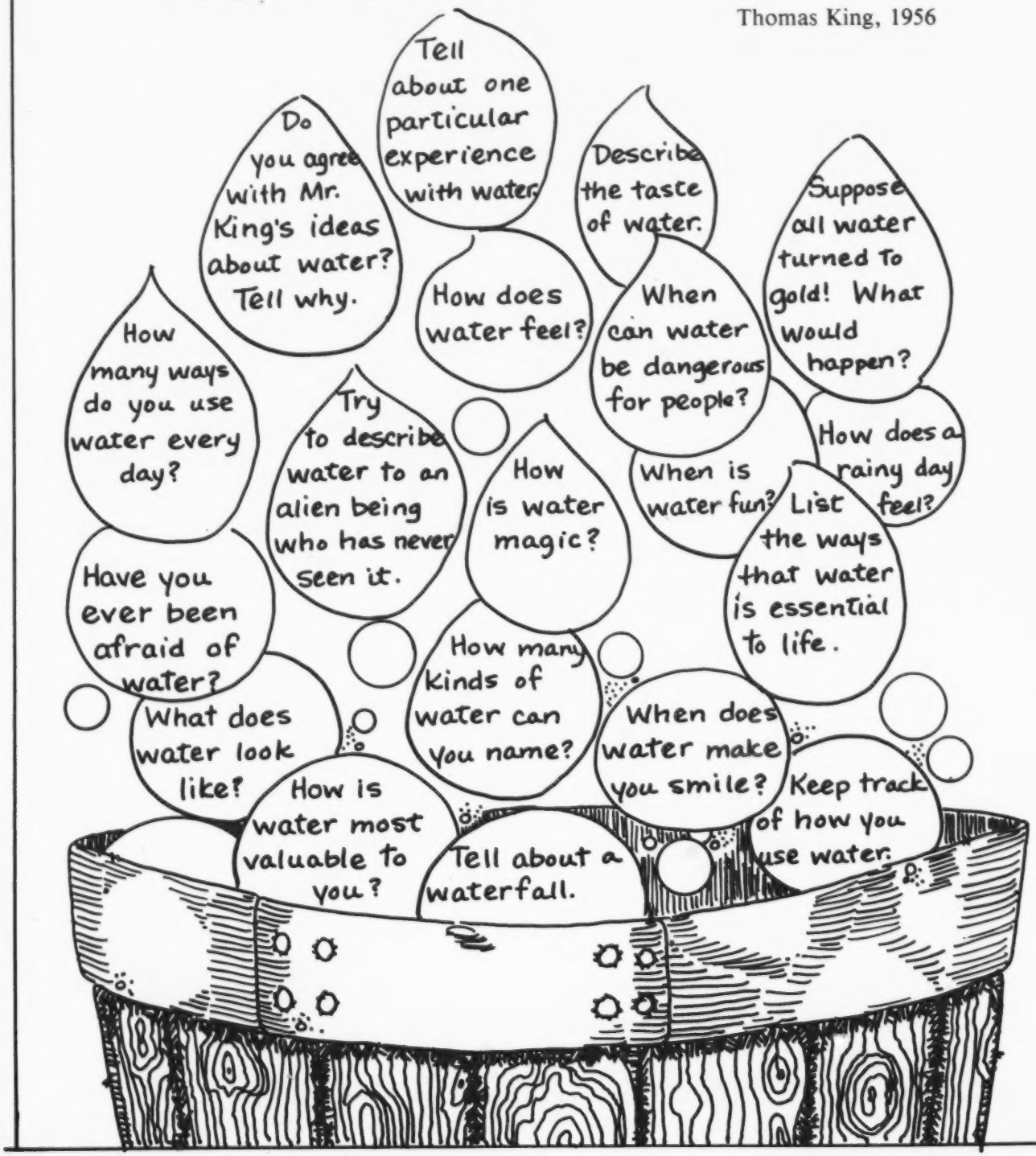
E. Particular attention is focused on the varieties of careers which involve the study of water. Limnology, oceanography, hydrology, geology, and meteorology provide the scientific backgrounds. Weather and news broadcasters, park rangers, engineers, farmers, archaeologists, computer programmers, and city planners have important roles in flood control and forecasting. The Red Cross, Amish volunteers, National Guard, firemen, policemen, doctors and nurses provide necessary public services in flood emergencies and cleanup campaigns.

Name _____

A DROP IN THE BUCKET

"Of all the substances that are necessary to life on earth as we know it, water is by far the most important, the most familiar, and the most wonderful; yet most people know very little about it."

Thomas King, 1956


Tell about one particular experience with water.
Do you agree with Mr. King's ideas about water? Tell why.
Describe the taste of water.
Suppose all water turned to gold! What would happen?
How does water feel?
When can water be dangerous for people?
How many ways do you use water every day?
Try to describe water to an alien being who has never seen it.
How is water magic?
When is water fun?
How does a rainy day feel?
List the ways that water is essential to life.
Have you ever been afraid of water?
How many kinds of water can you name?
What does water look like?
When does water make you smile?
Keep track of how you use water.
How is water most valuable to you?
Tell about a waterfall.

Name _____

SOME PROPERTIES OF WATER

Have you ever tried to carry a bucket of water across a stream and up a hill? What are some things that could happen before you reach the top of the hill? Would your arm start to ache? Could water spill or leak from the bucket? Make a list of some possibilities.

How does your list show things you **know** about water? Make another list of words that **describe** water.

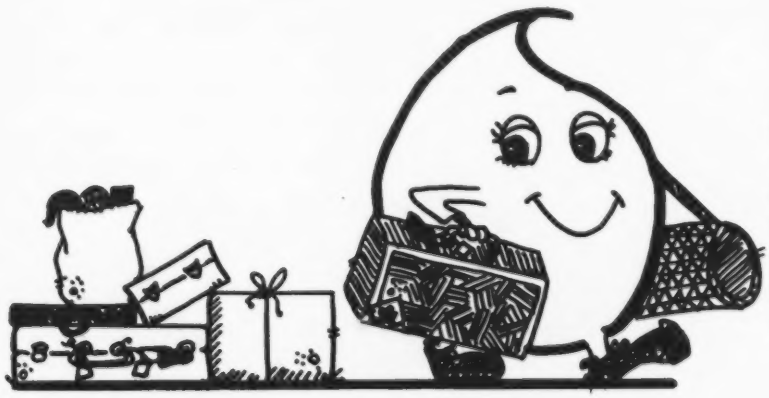
Try to carry a shallow pan filled with water across a room. . .better yet, try this **outside**! It doesn't take long for waves to start tipping the pan. Is it easy to control even this little bit of water?

Put a drinking glass sideways in a bucket of water. Holding the bottom of the glass, slowly lift it from the bucket. What happens to the level of the water in the glass? Why do you think this happens? Can you think of some other times when water defies gravity? Consider blotting paper or the plumbing in King Ludwig's famous Bavarian castles. **(Read to find out!)**

If one cubic foot of water weighs 62 pounds (it does!), how much does a king-sized water bed weigh (8′x 6′ x 1′)? What does a bathtub full of water weigh? What does a lake near your house weigh? What does a butcher weigh? (Meat!)

All the water on earth weighs nine million billion tons! When does water weigh almost nothing? Is ice heavier than water?

What's the difference between a tomato and a fifth grader? A fifth grader is about 65 percent water. A tomato is 98 percent water! The average man has about 50 quarts of water in his body.



Some of the water in the center of the earth has been there since the world began. How do you think scientists might study this ancient water? Water is loud when it comes with thunderstorms (10,000 a day on earth). When is water quiet? Have you ever listened to an ice cube?

How long does it take a tiny crack in your little brother's wading pool to drain all the water? How does water find that tiny leak. . .and where is it trying to go?

Water is smooth and slippery when you climb into a bathtub, but not so soft when you belly flop into a lake. Why?

These are just some of the **properties of water.** You know more about water than you thought you did!

Name _____

LIFE ON THE WATER PLANET

Water is an essential, life-giving element around which civilizations have grown and prospered throughout history. People have always gathered to build their homes and cities along the banks of life-supporting rivers and the shores of lakes and seas. Yet floods and droughts have always been a natural part of life along these waterways.

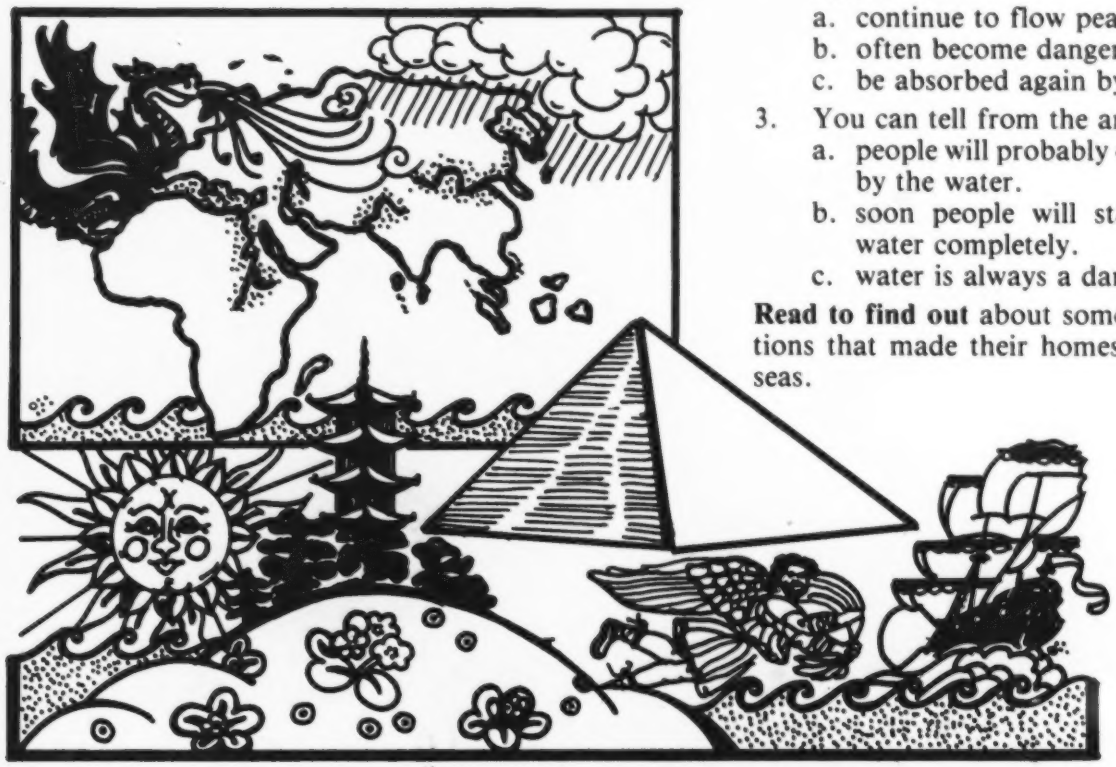
The same waters that provide abundant food and drink, transportation, rich soil, good fishing, pleasant recreation, and energy for mills and electricity can suddenly become destructive through flooding. Water is a powerful force that is difficult to control or contain. Too little water can turn a lush marshland into a dry, arid wasteland. Too much water too quickly becomes a raging giant that can destroy farmlands, homes, and villages. Floods can bring misery and disaster to modern cities.

Animal habitats and plant life can be drastically changed by torrential floodwaters or long periods of drought. Above all, many human lives are lost to these natural catastrophes.

Since it is unlikely that people will move away from floodplains, it makes sense to understand what causes floods and droughts, and what can be done to protect families and property.

1. People like to live by water because
   a. it is the first place they came to.
   b. it is an essential, life-giving natural resource.
   c. swimming is healthy exercise.
2. When too much water falls too quickly, rivers will
   a. continue to flow peacefully.
   b. often become dangerous floods.
   c. be absorbed again by the soil.
3. You can tell from the article that
   a. people will probably continue to live by the water.
   b. soon people will stay away from water completely.
   c. water is always a dangerous force.

Read to find out about some early civilizations that made their homes by rivers and seas.



Name _____

ANCIENT STORIES OF FLOOD AND DROUGHT

". . .the flood was forty days upon the earth; and the waters increased, and bare up the ark, and it was lift up above the earth. . . And the waters prevailed exceedingly upon the earth; and all the high hills that were under the whole heaven, were covered."

Genesis 7:17-19

Since people have always depended on water for life, even the earliest civilizations learned to respect, appreciate, and sometimes fear water. Floods and droughts often changed the whole world as they knew it. Legends and myths explained these natural catastrophes in ways which the early people could understand.

Ancient Babylonians told about a worldwide flood caused by Enlil, a god who couldn't get any sleep because people on earth were making too much noise. He sent pests, plagues, and then droughts. Finally, he destroyed the world with the worst disaster of all—a flood!

Lithuanian folklore tells about a god named Pramzinas who created a flood to abolish all mankind. Then he sat down in the heavens for a front row seat to watch the disaster while eating some nuts. He dropped a nutshell onto a mountain below, and a few lucky people used it as a boat to ride out the flood.

1. The Babylonian legend shows that people believed a flood could be caused by
   a. land saturated by water.
   b. an angry god.
   c. too much rainfall in a short time.
2. In the Lithuanian story, mankind was probably saved by
   a. careful planning and scheming.
   b. an accident.
   c. a kindhearted god.
3. From these myths, you can tell that early people
   a. considered floods the worst disaster of all.
   b. understood exactly how flooding occurs.
   c. realized that floods were part of the natural cycle.

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Name _____

LEGENDARY GREEK FLOODS

The Greek philosopher, Plato, described the legendary city of Atlantis as a great civilization that built temples, ships, and canals. The Atlanteans had conquered all of the known world by 9600 B.C. except for Greece. The Greek islands were miraculously spared when Atlantis was covered by water and disappeared forever.

Thousands of teachers, scholars, scientists, and historians have studied stories about the Lost City of Atlantis. Some say it may have been located in the Atlantic Ocean west of Gibraltar, others think it might have been between Sicily and Italy. No one knows for sure, but many people are still looking.

Greek legends tell another ancient story of floods and droughts. It is said that a powerful god drove his father's chariot, the sun, too close to earth. Terrible droughts occurred, and soon the world caught fire. Zeus sent a flood to put out the fire. Fortunately, the human race was saved when Zeus warned Deucalion and his wife, Pyrhha, to build a chest to float in safely until the floods ceased. When the couple landed on Mt. Parnassus, they were told to throw rocks over their shoulders. The rocks became people, and a new civilization began.

1. The ancient cities of Troy, Herculaneum, and Pompeii were once considered to be myths. Archaeologists have since discovered the buried remains of these cities. Based on this, we know that Atlantis
   a. never really existed.
   b. may possibly have been a real city and civilization.
   c. still exists somewhere today.
2. The Atlantic Ocean may have received its name from
   a. the famous Greek philospher, Plato.
   b. the legendary city of Atlantis that might be lost beneath its waters.
   c. the scientists who study it.

Read to find out myths about floods and droughts in Egyptian, Persian, Hindu, and South American legends.

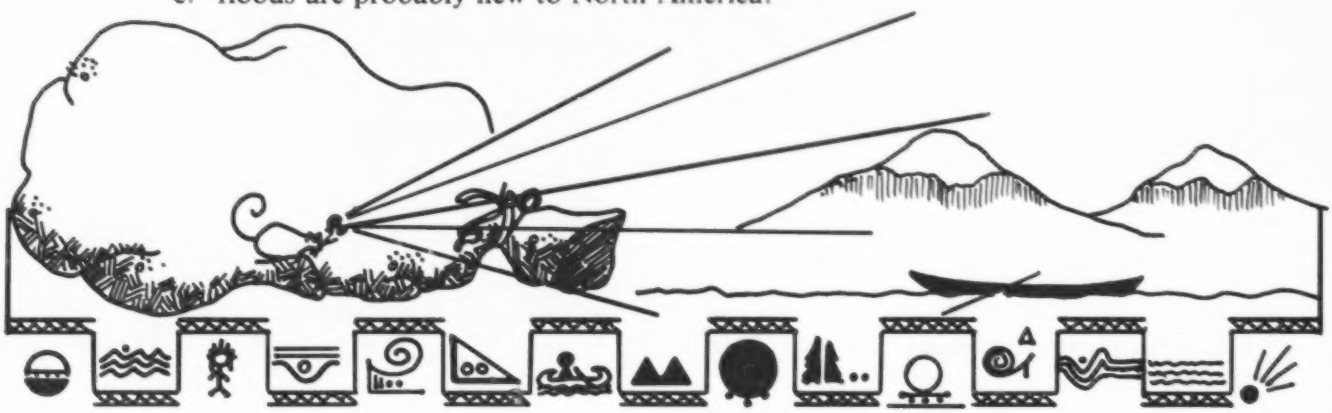
Name _____

INDIAN FOLKLORE

The Creek Indians tell about a dog who advised his master to build a raft so they could ride out a terrible flood together. The Indian and his dog were the only two creatures to survive the deluge.

Long into the cold Minnesota nights, Chippewa Indians told this story to young tribesmen. All the sun's heat, they say, was trapped inside a huge leather bag. A very tiny mouse gnawed a hole in the bag. This caused all the ice and snow in the world to melt. A disastrous flood covered the earth.

1. The Chippewa Indian tale shows that people believed that terrible catastrophes could be caused by
   a. only the most powerful gods.
   b. very small, insignificant creatures.
   c. natural atmospheric condition.
2. The Chippewa Indians were probably very accustomed to
   a. ice and snow through very long, cold winters.
   b. sunshine most of the year.
   c. modern weather forecasting techniques.
3. You can tell from the stories that
   a. Indians in North America had experienced giant floods.
   b. the Indian people had never had a flood.
   c. floods are probably new to North America.



Indians told their stories in music and dance. Sometimes they painted legends on their teepees and canoes. They carved their myths into pottery and birchbark. The Indians used symbols taken from nature: the sun, moon, rivers, trees, and mountains. They used their imagination to sign more complex ideas. Perhaps they used a broken arrow to show peace.

Tell a water legend of your own in Indian sign language. Remember that whole ideas can be shown with a single symbol. You don't need **the** or **is** or **who**. Use your imagination! Then read your story to the class if you wish.

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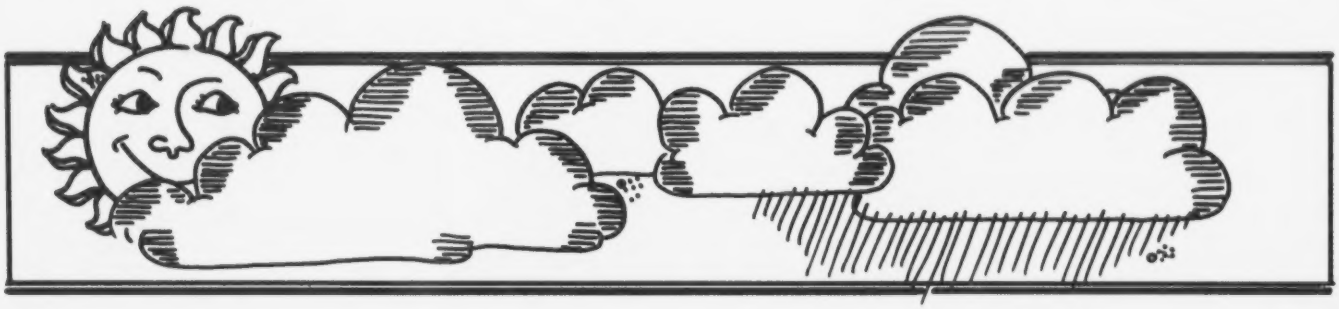
MY OWN INDIAN LEGEND

Name _____

FLOODS AND DROUGHTS IN THE NATURAL CYCLE



It is easy to see why stories about floods were so common in early cultures. Modern studies show that more people are killed by floods than by the next eighteen natural disasters together (volcanoes, earthquakes, tornadoes and so forth).

Today, people understand that floods and droughts are a normal part of the hydrologic cycle. Water vapor enters the atmosphere through evaporation from oceans, lakes, and land masses. Most of it evaporates again, but some of the water seeps deep into the ground or enters lakes, rivers, and oceans.

Only a very small percentage of the water supply on earth is in the atmosphere at any one time. Depending on atmospheric conditions (like wind and temperature) and the energy of the sun, some regions of the world may receive way too much water while others receive none at all. Sometimes land masses like mountains play an important role in the hydrologic cycle. In Hawaii, for example, 460 inches of rain fall every year on Mount Waialeale while only 18 inches fall at sea level just 15 miles away.

When the ground cannot absorb heavy rains or melting snow and when the streams and riverbeds cannot contain the water in their channels, temporary flooding occurs. Seasonal flooding and drought can be beneficial when they provide nutrients to floodplain soil and maintain ecological balance for plant and animal life.

1. Stories about floods in myths and legends are so common because
   a. people remember them very easily.
   b. floods are very unusual and memorable.
   c. flooding has always been a natural catastrophe.
2. Seasonal flooding occurs when
   a. soil and plant life cannot absorb rainwater or melting snows.
   b. streams and riverbeds cannot contain the water running into them.
   c. both of the above occur.
3. From this article you can tell that seasonal floods are usually
   a. very rare.
   b. natural occurrences.
   c. preventable.

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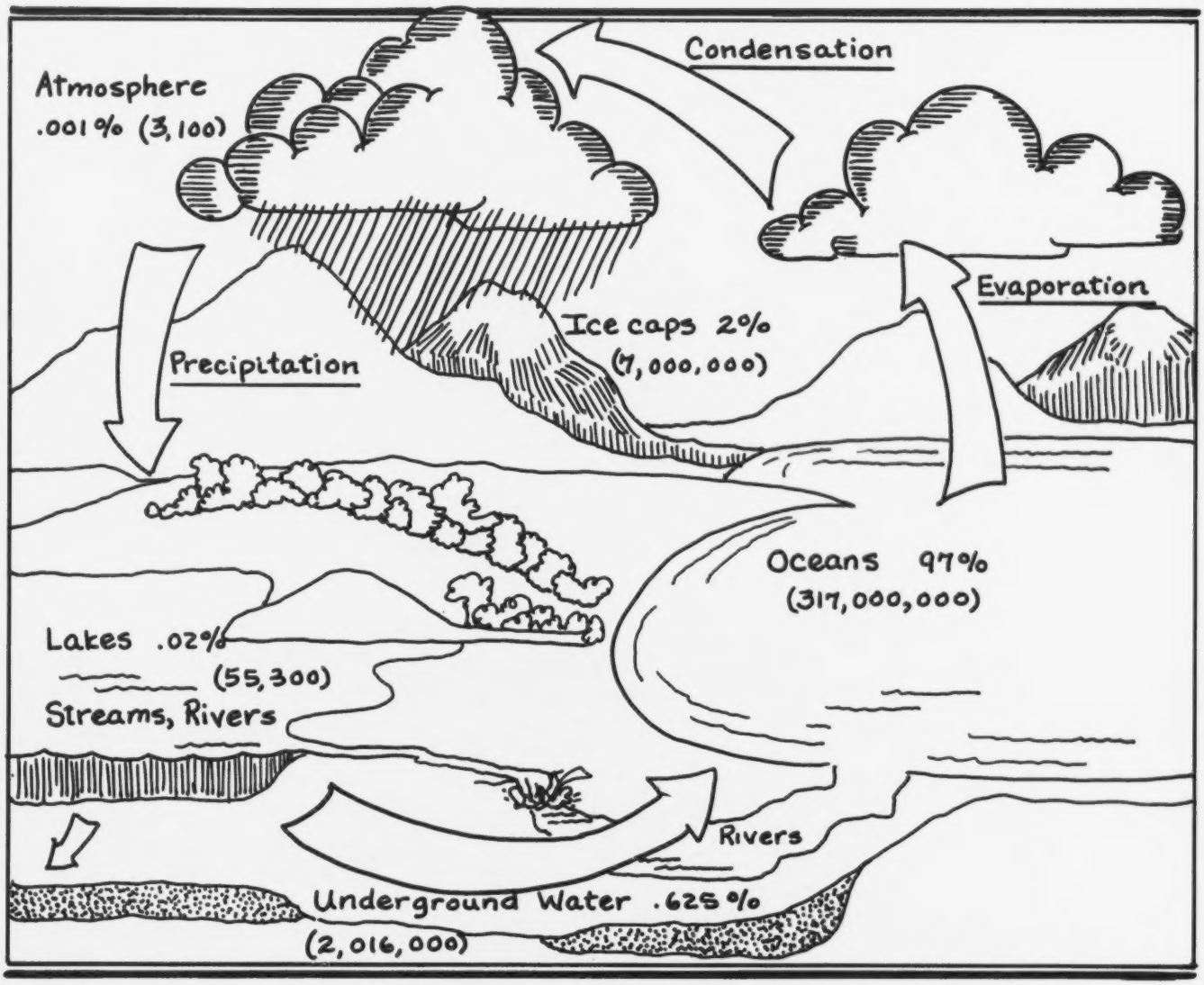
Name _____

THE HYDROLOGIC CYCLE



The same water we drink today was soup for the Roman legions, lapped up by sabre tooth tigers, and rain at the Battle of Gettysburg. Through a circulation system known as the hydrologic cycle, the water in the earth's environment has been continually purified and recycled for billions of years. The amount of water in this system has always remained the same.

When you color the picture of the hydrologic cycle, pay careful attention to the amounts of water in the different parts of the environment. Where is most of the water in our world? Water at the bottom of the ocean may take 2000 years to be recycled, while a gentle raindrop may evaporate on a leaf and be recycled before it ever touches the earth.

Name _____

SEASONAL FLOODS

Every year, ten million billion gallons of water is carried into the atmosphere through evaporation. Still, only 1/100,000 of the total supply of water on earth is actively involved in the hydrologic cycle at any one time. Eventually all of this water falls in the form of rain or snow. The amount of precipitation available to any one area, however, varies tremendously.

Sun, prevailing winds, and even ocean temperatures affect rainfall. While some areas experience drought, others have terrible floods. Most floods are caused by too much rainfall. The ground becomes saturated and the riverbeds fill to the brim. When water cannot be carried in normal channels, flooding occurs.

Sometimes melting snow in the mountains can cause catastrophic flooding in sunny valleys far away. Hurricanes can destroy coastal areas and cause disastrous flooding far inland. Earthquakes under the ocean floor cause huge tidal waves, called tsunamis, that smash into coastal cities with tremendous force.

The only place in the world that does not have floods is the continent of Antarctica at the South Pole. In North America, there is at least one flood every month that is heavy enough to be recorded. Floods can occur in both rural and urban areas. North American Indians tell of floods hundreds of years ago in the same places that we still experience floods today. Early explorers from Europe were delayed by floods along the Mississippi River. Over 10,000 floods in the United States have occurred since those first settlers arrived.

1. The amount of rain or snow in any particular area depends on
   a. what the people in that area need.
   b. the season of the year.
   c. a variety of conditions like winds, sun, and ocean temperatures.
2. Floods are likely to occur
   a. when riverbeds are full and the ground is saturated with water.
   b. every ten years in a particular area.
   c. whenever it rains heavily.
3. It is easy to see that people must find ways to
   a. live without water.
   b. protect themselves from floods since they must live near water.
   c. change the way water acts.

Name _____

DROUGHTS

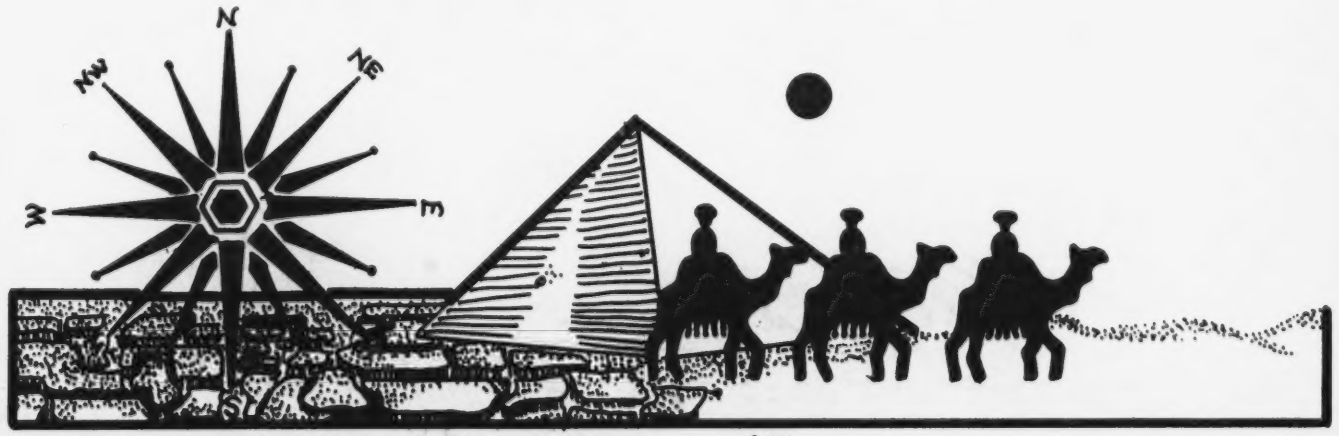
It is easy to see why most people assume that water is always going to be available to them. There appears to be a plentiful abundance in rivers, lakes, and streams. Sometimes they complain about too much rain when March and April seem to stretch long before the bright sunshine of summer.

A widespread drought in the early and middle 1960's made many Americans painfully aware of the precious treasure to be found in water. People recognized the need to cut down on amounts of water used for washing cars, watering the lawn, taking long showers, and filling the swimming pool. It's a good idea to conserve this valuable natural resource even in times of plenty. There is a limited supply of fresh water in a world that has growing populations with rapidly multiplying water needs.

Drought is difficult to define. If there is not enough water in a particular area to sustain plant and animal life in its usual fashion, then there is a drought in that region. Prolonged dry spells can cause as much human misery and property damage as floods.

The National Oceanic and Atmospheric Administration uses reporting stations, computerized measurements, and even satellites to monitor drought conditions in the United States. Agricultural experts use this data to estimate annual production, irrigation needs, soil management projections, and possible problems that follow dry conditions.

1. People assume that there will always be an abundance of water because
   a. water is such a common resource and such an ordinary part of our everyday life.
   b. there have rarely been any droughts in our country.
   c. most people have not personally experienced drought conditions.
2. Many of the ways we use water are
   a. limited.
   b. wasteful.
   c. thoughtful.
3. Experts study drought conditions so they can
   a. suggest ways to cope with long dry spells.
   b. prevent droughts in the future.
   c. tell farmers a drought is coming.



Name _____

EL NIÑO: A MAJOR WEATHER CHANGE

Seasonal floods and droughts are beneficial to some areas. In the Florida Everglades, for example, they provide nutrients to floodplain soil and maintain ecological balance for plant and animal life.

Sometimes normal weather patterns are disrupted on a worldwide scale. When the Pacific Ocean gets hotter at the equator, Spanish people call the weather changes that follow its path El Niño. There have been eight Niños in the last fifty years, but the one in 1983 brought flood, fire and drought to nearly every continent in the world.

The warm waters changed wind patterns, salt content of the Pacific, ocean currents, and sea levels. Huge warm waves flooded South America, the West Coast of the United States, and the Gulf of Mexico. Mud slides, record snowfalls, and torrential rains followed. Whole populations of seabirds and fish disappeared, and coral reefs vanished.

Meanwhile, extreme droughts affected South Africa, Australia, Mexico and Indonesia. Water supplies were reduced, crops failed, and grazing lands disappeared. In all, over 1000 people died from El Niño, and damages reached nearly 10 billion dollars worldwide. Fortunately, the history of El Niños shows that it is not likely that another will come again very soon.

1. The warming of the ocean at the equator
   a. has nothing to do with the rest of the world.
   b. can cause weather changes that bring floods and droughts to the rest of the world.
   c. happens every year.
2. Seabirds and fish are guided to nesting areas and food supplies
   a. by ocean currents, wind patterns, and weather.
   b. by a natural timetable unaffected by outside forces.
   c. by road maps and signs.
3. Since there has been a cluster of catastrophic Niños in the past fifty years, there is
   a. probably going to be another one next year.
   b. probably not going to be any more for awhile.
   c. going to be one every year from now on.

Name _____

PEOPLE CAN CAUSE FLOODS

Flooding along rivers and seashores is a natural part of the water cycle. Droughts occur when there is too little water to sustain plant and animal life. Modern communities must learn to live with the natural cycle of flood and drought by improving forecast systems and planning for emergencies. But there is even more to understand about water in today's world.

Too often, floods and droughts are caused by people themselves! In an effort to harness water power, people build dams and levees along rivers. These man-made barriers prevent the natural flow of water. Excess water accumulates where the ground is less prepared to absorb it. Other areas dry up because no water reaches them at all.

The tremendous pressure of water constantly wears away the foundation and structure of dams. They must be continually monitored for signs of erosion or weakness. When dams break or levees give way, walls of water can destroy entire communities within minutes.

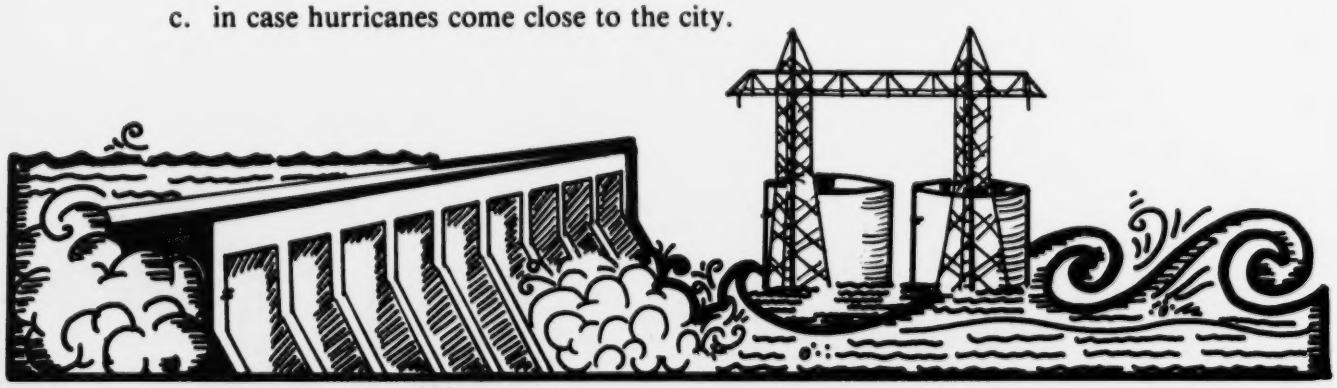
People hold huge amounts of water in reservoirs to serve areas where seasonal drought is likely to occur. This prevents water from flowing to other areas. Marshes are drained to enlarge farming areas. Wetlands are drilled for oil. Rivers are straightened so cities can creep closer to water supplies. Concrete and asphalt pave urban areas where water seeped into the ground for thousands of years.

1. A dam is a man-made barrier. List at least four other man-made barriers from the article above.

   _____ _____

   _____ _____

2. Some other man-made barriers are
   a. seashores and coastlines.
   b. cliffs, seasons, and fires.
   c. stoplights, curbs, deadlines, and fences.
3. People build dams, levees, reservoirs, and canals
   a. in an effort to use the power of water.
   b. in order to cause floods.
   c. in case hurricanes come close to the city.



BUFFALO HOLLOW, 1972
A TRAGIC ACCIDENT

Until that Saturday morning in 1972, Buffalo Creek was a small mountain stream winding through a peaceful Appalachian Mountain valley in the coal mining heartland of Logan County, West Virginia. Railroad cars loaded with heavy, black coal stretched beside the creek from the Buffalo Mining Camp at the top of the narrow valley to the tiny town called Man, twenty miles downstream at the Guyandotte River.

During World War II, the miners could hardly produce enough coal to meet the needs of steel companies making planes, tanks and ships. Tons of useless rock, called slag, were stripped from mountains to get to the valuable coal. The slag was dumped in a valley just above Buffalo Hollow. Soon the dump blocked little streams that had entered Buffalo Creek. A huge lake began to form behind the loosely piled slag.

Years of mining had removed trees and ground cover from the mountainsides. Melting snow and heavy rains ran down the bare slopes, and the lake grew larger and faster. Sometimes a coal mine would fill up with water from underground beds. This, too, was drained into the new lake. Meanwhile, the slag dam grew to over a hundred feet high.

Unlike carefully engineered dams, the slag dam had no valve for runoff, no cement for reinforcement, and no planned structure for safety. The bottom of the lake was full of thick, black slime and sulphuric acid from the coal mines.

Some people in the valley began to worry about their safety. They complained to the coal mining company, but nothing was done to strengthen the dam or to drain the lake. As years passed and the dam held, people tried to ignore the threat just above their peaceful valley.

The snows during the winter of 1971 were especially heavy. The people of Buffalo Hollow welcomed the warm rains and bright sunshine that came unexpectedly in the middle of February, 1972. Suddenly the snow was gone, and the creeks throughout the mountains splashed along with their waters brimming to the top of their narrow banks. More people worried about the lake behind the slag pile. Mining company officials insisted that the dam was sound. Still the water continued to rise.

Deputy Sheriff Otto Mutters was one of the people who was especially worried about the families in the valley. He knew that if the water ran over the top of the slag dam, the loose rock would begin to crumble and the whole lake would rush in a giant wall toward the tiny mining villages in the hollow.

Early on the morning of February 26, 1972, Sheriff Mutters heard that the lake was within a foot of the top of the dam! He drove up and down the valley shouting for people to get out of their beds and head for higher ground. A few people listened. Many people had heard rumors of the dam breaking before. Some thought it would continue to hold as it had in the past.

As the sun rose through the warm falling rain, even the mining company officials saw the danger. They, too, drove down the road through the valley, honking their horns and shouting for people to run. But it was too late.

A terrible roar echoed through Buffalo Hollow at 8 o'clock that Saturday morning. All electricity went out. Twenty million cubic feet of water burst from the crumbling dam. Cars, houses, churches, and bridges were crushed by the awesome force of the water. As it spread out, a black wall of water over 40 feet high crashed through town after town along the valley. The wall was filled with huge boulders and uprooted trees. The churning, black water threw 50-ton railroad cars into the air. Houses were ripped into piles of sticks, and every person in them was killed. A few people further down the valley were able to scramble up the side of the mountain as the black wall roared towards them.

In less than an hour, over a hundred people were dead. Hundreds of families lost their entire life's work and savings. No home remained, no town, no railroad tracks, no bridge. The Buffalo Hollow flood was a terrible accident.

Think about the Buffalo Hollow flood. As a class, or with your small group, talk about the combination of events that caused this flood. Consider all the ways that the people of Buffalo Hollow could have been spared from this tragic accident.

Read to find out about the dedicated people who worked to help Buffalo Hollow after the flood. There are several books about this accident and information in the *Readers' Guide to Periodical Literature.*

Read to find out about other flash floods caused by accident or nature. Some of these include Big Thompson River, Colorado, 1976; Charlottesville, Virginia, August 19, 1969; Mouse River, North Dakota, April, 1969; and Kansas City, 1977.

Name _____

PEOPLE WORKING TOGETHER

A flood warning is only effective if it reaches people in time for them to react. Sometimes seasonal flood warnings come days or even weeks ahead of time. Farmers have a chance to bring in valuable crops or move cattle to higher ground. People can take precautions to save some of their personal property. Often, there is much less time to prepare. Communities must know what to do during a flood warning so they can act quickly to minimize damage and to save precious lives.

More than $250 million worth of property is lost or damaged annually in floods across the United States. Nearly 100,000 Americans are driven from their homes, and 200 persons are killed in floods! Communities must have a plan to receive warnings twenty-four hours a day, and to pass them on effectively to the people in their areas.

Every family in a community should know what the warning means for them. They should know the nearest safe area, the height of their property over flood levels, good evacuation routes, and systems for informing their friends and relatives in case telephone lines are out. Families should plan a meeting place above the flood level so that lives are not needlessly endangered as people return for family members who are already safe.

You will probably hear flood warnings or flood watches on your radio or television sometime this year. If you understand the nature of floods and what can be done to prevent flood damage and **if you know what to do during flooding conditions,** you may never be caught in a major flood.

1. If you know what to do during a flood, you might
   a. be more afraid of it.
   b. tell people not to worry about it.
   c. be able to help save yourself and your family.
2. If the NOAA flood warning system is effective,
   a. communities receive information and pass it on to families who know how to react quickly.
   b. there will never be a flood in most areas.
   c. more lives will be lost to floods each year.
3. Farmers are particularly quick to react to flood warnings because
   a. they must save themselves.
   b. they want to save their animals and crops in addition to themselves and their families.
   c. there are more floods on farmlands every year.

Name _____

FLOOD WARNING SYSTEMS

The **National Oceanic and Atmospheric Administration** (NOAA) keeps a watch on water levels and conditions across the United States twenty-four hours a day every day of the year. From **River Forecast Centers,** hydrologists relay information about water flow, meteorological conditions, and water level expectations to the **National Weather Service.** Scientists carefully record rainfall, atmospheric conditions, and approaching weather systems. Together, these experts provide continual information so people will have time to protect themselves and their property before a major flood strikes.

Flood warnings are forecasts of possible floods in a particular area. The warning message is usually carried by local radio and television stations. It tells the degree of flooding expected, the area affected, and when the flooding will probably begin.

1. A flood warning tells you that a flood
   a. might occur soon in your area.
   b. is happening somewhere right now.
   c. occurred yesterday in your area.
2. Time is especially important when people are warned about floods because
   a. they must act quickly to get out of the way of the water.
   b. they can stay where they are until the last minute.
   c. they need months to get ready for the flood.
3. River Forecast Centers are a vital source of information for the
   a. Fish and Wildlife agencies.
   b. local radio stations.
   c. National Weather Service's flood warning system.

FLOOD SAFETY RULES

During any flood emergency, the NOAA suggests that communities stay tuned to radio and television stations which provide information that could save lives. The NOAA also lists the following flood safety rules:

BEFORE THE FLOOD

1. Keep materials like flashlights, batteries, battery-operated radios, and emergency cooking equipment on hand and in good working order.
2. Keep sandbags, plywood, plastic sheeting and lumber available if you are in an area that is likey to flood often.
3. Keep first aid supplies on hand.
4. Keep the family automobile fueled. If electric power is cut off, gas stations may not be able to pump gas for many days.
5. Keep a stock of food which requires little cooking and no refrigeration on hand.

WHEN YOU RECEIVE A FLOOD WARNING

1. Store drinking water in various containers. A clean bathtub is a good place to keep water that might be the only fresh water available during a major flood.
2. If forced to leave your home, and if time permits, move essential or valuable property to safe ground.
3. Move to a safe area before access is cut off by flood waters. Do not wait until the last minute!

DURING THE FLOOD

1. Avoid areas where sudden flooding could occur (valleys, gullies, basements, cellars).
2. Never attempt to cross a flooding stream where water is knee-level or above.
3. Do not attempt to drive over a flooded road. The car might easily become stranded and you would be trapped.

AFTER THE FLOOD

1. Do not use fresh food that has come in contact with flood waters.
2. Test drinking water before using it. It may easily be contaminated.
3. Seek medical care, food, clothing, or shelter if necessary.
4. Do not touch any live electrical equipment in a wet area.

Name _____

FLASH FLOODS

Flash floods are perhaps the most deadly of all floods. They are almost impossible to forecast accurately, and they can occur in mountain areas, on small streams, and in the heart of large cities. Moving at incredible speeds, they sweep bridges, boulders, and buildings along with their roaring, rolling waters. Waves become giant walls of water. Entire areas can be wiped out in minutes.

If you are camping near a small stream, in a valley, or in the mountains during rainy weather, watch for environmental clues that tell you the area is likely to flood soon. In mountains where many tiny brooks join a main stream, flash foods can be particularly dangerous. At the foot of mountains, especially during long periods of dry weather, the hard ground receives massive quantities of water too quickly for it to be absorbed.

Cities that have been paved and asphalted and covered over leave no place for heavy rains to be soaked into the ground. A great many people, buildings, and cars are often crowded together so evacuation is difficult and slow. Flash flooding requires immediate action.

A **flash flood watch** is issued when flash flooding is possible within a designated area. It tells you to be alert to flooding conditions.

A **flash flood warning** is issued when a flash flood has been reported or is actually happening at that time. **It means act quickly to save yourself.** You may have only seconds.

1. Flash floods are particularly deadly because they
   a. cover more area than seasonal floods.
   b. take more lives than other floods.
   c. are almost impossible to forecast and move at incredible speeds.

2. Heavy waters that are moving very quickly probably have
   a. very little power.
   b. tremendous power and force.
   c. small streams following them.

3. From this article you can tell that flash floods
   a. can happen almost anywhere.
   b. only happen in country areas.
   c. allow plenty of warning time to prepare for them.

Name _____

PREDICTING FLOODS AND FLASH FLOODS

We make decisions based on the weather practically every day of our lives. We choose whether to go on a picnic or to a movie, what kind of clothes to wear, and whether we should mow the lawn or wash the car. Some decisions based on weather and climate information made by farmers, scientists, and business people can have much broader effects on society. Flood forecasting is particularly essential.

While accurate weather forecasting is limited, it is still highly effective. Seasonal flooding can also be predicted with precision. Flash flooding, on the other hand, is almost impossible to forecast accurately at this point.

Heavy downpours are one major cause of flash flooding. Scientists can watch the clouds gathering, but often have no idea where or when **sudden** showers will drop inches of rain in a very short period of time. Flood forecasts are based on radar observations, measured rainfall, precipitation forecasts downstream, satellite pictures, computer models of the atmosphere and the terrain, the past history of a stream or riverbed, soil conditions, and data from thousands of observation points. Obviously, heavy cloudbursts in a particular region do not allow all this information to be processed in time to warn people.

Scientists are working with automated rain gages (spelled differently from rain gauges you may have made in the past) that send signals from electronic equipment in the river directly to 24-hour alarm stations in communities. These messages permit safe evacuation routes to be used. Do you know where there is a river gage in your area? Your county officials might be able to tell you more about them.

1. Computer models of the atmosphere and terrain
   a. are the latest kind of video game.
   b. are used in schools to teach about weather.
   c. can be highly effective in the accurate prediction of floods.

2. If there are low, heavy clouds in the sky, you will probably
   a. decide to go to the park for a ball game.
   b. choose not to go to school that day.
   c. need a raincoat or umbrella during the day.

3. You can tell from this article that
   a. progress is being made in the forecasting of flash floods.
   b. scientists can always tell when a flash flood is coming.
   c. farmers aren't particularly interested in flash floods.

TAKING A SECOND LOOK

Years ago, weather was measured by the frost on the teepee and by the flowering warmth of an early spring. Thermometers brought increased accuracy. The windchill factor tells how cold it is when the wind is blowing in a certain direction at a certain speed. Humidity makes hot days more uncomfortable.

Now scientists and climatologists are looking at yet another factor that provides increased accuracy in weather measurement, the stress index. A person feels hotter or colder, more or less comfortable depending on what kind of weather he is used to. The NOAA has weather stress index tables based on weather history in over a hundred areas around the United States. It is published in Climate Impact Assessment magazines. Climate experts say there is no physical reason why a person from Florida should feel most uncomfortable in weather that a Minnesotan would find suitably warm. It is the person's expectations, they say, that make him feel worse.

How do you feel on rainy days? What kind of weather makes you feel bright and energetic? When do you think tensions increase and people are more likely to argue? Write a weather story about feelings.

While you're at it, think about water again. It deserves more than a second thought!

In *Don Juan*, Lord Byron said,

"Till taught by pain
Men really know not what good water's worth."

Compare his statement with Samuel T. Coleridge's "Water, water everywhere, but not a drop to drink. . . ."

Have you ever had an opportunity to really appreciate one of water's many unique functions? Think about a long drink of water after jogging on a warm day, splashing in an icy stream on a humid summer afternoon, or slipping into a warm bath after a morning of cleaning the garage. Have you ever spent an evening watching the sun set over a favorite lake or seashore?

Name _____

FLASH FLOOD SAFETY RULES

The National Weather Service has issued a special set of instructions for flash flood safety. Although improvement is constantly being made in flash flood warning systems, experts suggest that you be ready to act on your own if you see signs of flash flooding. There may not be time for official warnings.

In cities, keep out of low areas. This includes storm drains, along street curbs, in gullies, or even in your own basement. Water can become deep in a very short time. Sometimes currents can move so quickly that shallow water can sweep you away. Electrical wires are particularly dangerous if they come in contact with water.

In the country, whenever it rains or there is thunder and lightning in nearby hills, be ready to move quickly to high ground. Stay away from canyons, washes, ravines, or any low spots. Stay away from tall trees or hilltops if it is lightning.

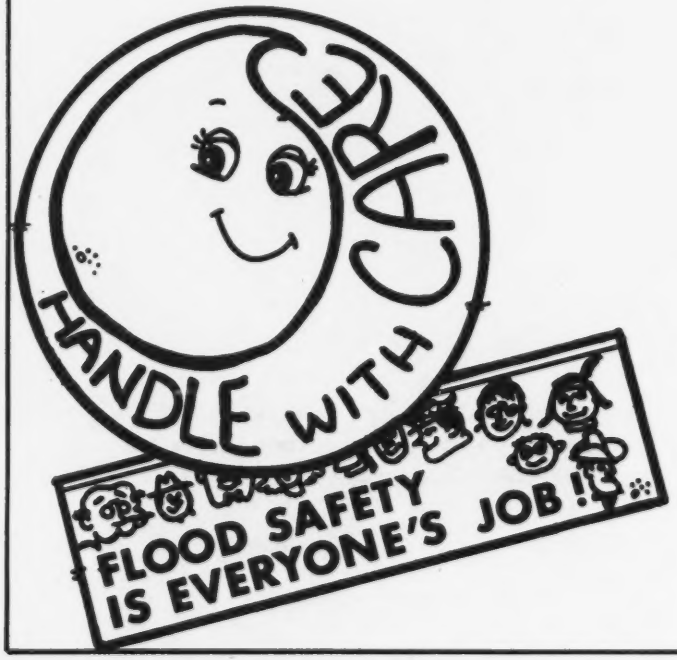
If you are in a car, watch for flooding at bridges or dips in the road. Never drive where water is rapidly rising. It could easily stall the car, and you'd be trapped. Flood waters can wash cars, trucks, and even trains away! Know the depth of the water before crossing. The roadbed may have already washed away.

If you are camping and your vehicle is trapped in water, leave it immediately. Climb to high ground. Be especially careful at night when you can't see the flood conditions. Never try to cross water that is higher than your knees. Do not camp along streams or washes when rainy weather threatens.

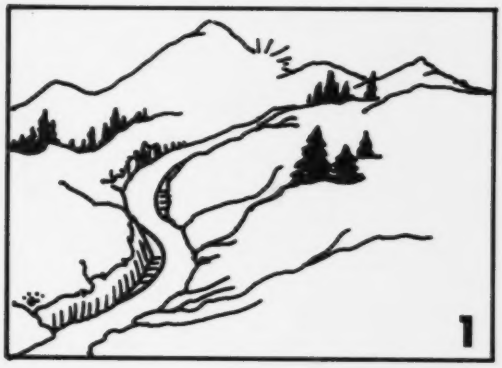
Name _____

CAMPAIGN FOR FLOOD SAFETY

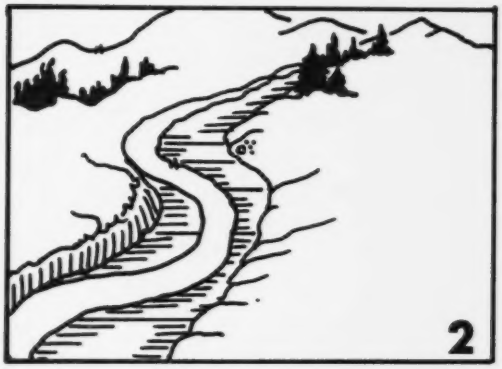
Plan a flood safety campaign for your community. Use the information you have learned in this unit to build your campaign. Use your imagination to attract the interest and attention of your town! Brainstorm slogans for buttons, posters, billboards, and bumper stickers. Design an editorial cartoon emphasizing flood safety and write a letter to the editor. Think about flood safety for people traveling through your area, for campers, and for people living in congested city areas. Work in small groups, with a friend, or by yourself. Try to think about flood safety from many different angles. Use this page as a beginning!



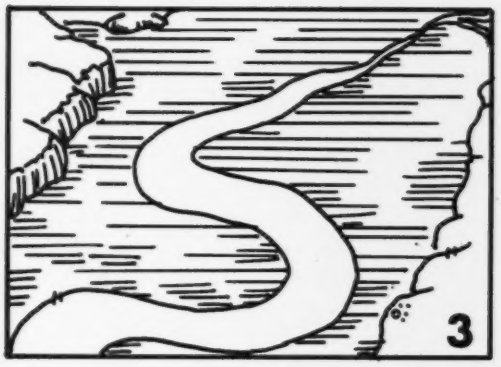
A STORY OF THE RIVER AND ITS PEOPLE



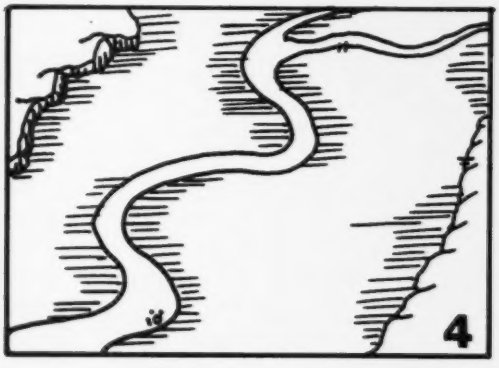
High in the mountains, a gentle spring rain forms rills in the melting snow and seeks crevasses to become sparkling streams. As it gathers speed, the young river is joined by other streams that add to its volume of water.



The river's route is a V-shaped, snake-like **channel.** As it rushes against its outer curves, it cuts away bits of soil and vegetation from the hillsides. As the water flow increases and decreases with the seasons, this **silt** is deposited on opposite banks. A **floodplain** begins to form.



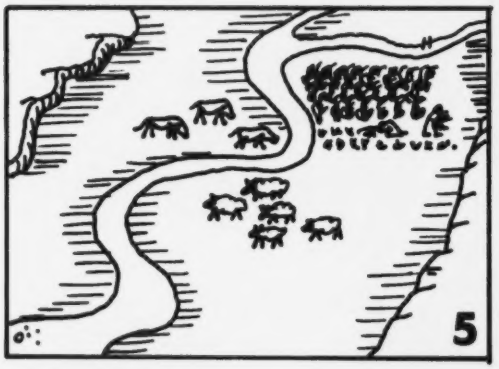
Over hundreds of years, the river spills out of its banks many times. The valley broadens, the natural flatlands grow wider and richer with **alluvial** soil that provides excellent farmlands growing richer with each new flood.



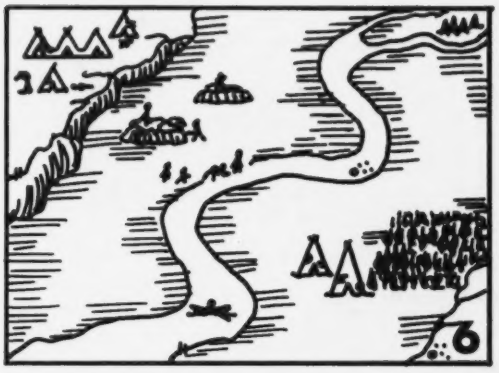
An old river has a winding channel and many miles of low, sweeping flatlands extending far beyond its banks. The valley floor is raised with each new deposit, and natural **levees** keep regular flooding within these regions.

Read to find out how ancient Egyptians welcomed the annual foods that brought rich soil to the Nile Valley. Discover how early civilizations like those in China, Mesopotamia, and Rome grew along the banks of mighty rivers.

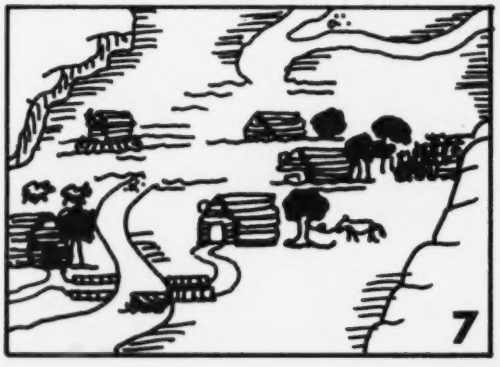
Early civilizations around the world chose to live by water. The rich soil supported farmlands while the flatlands provided grasses for grazing animals. The river offered plentiful drinking water, fishing, and a way to move quickly from place to place.



Indian communities flourished along the Mississippi River in North America. When the rivers began to flood, the Indians would simply move to higher ground. Some tribes built earth mounds on the floodplain for additional safety and temporary homes during floods.



Early European settlers soon realized the benefits and the hazards of life along the river, but their homes were not so easily moved. The new communities planned ways to prevent the mighty river from leaving its channels.



American settlers built levees, **dikes**, and flood walls. They soon realized that controlling a river with man-made barriers increases both the speed and volume of the water. This causes **erosion** along the banks and heavier flooding in unexpected areas further downstream.

Read to find out about modern cities along famous rivers like the Thames, the Rhine, the Seine, and the Yellow River. One-tenth of the world's population lives on the banks of the Yangtze River in China!

Despite the constant struggle with its waters, modern communities continue to establish themselves along floodplains. Construction of homes, factories, and office buildings is easier and cheaper on the flatlands. Industries need water to manufacture and transport goods.

Today it is estimated that one-third of the world's population depends on alluvial soil for food. Farmers need rich, fertile soil. Over twenty million people in the United States live on floodplains. Twenty thousand communities flourish along rivers, lakes, and coastal regions.

Cities like St. Louis, Missouri, are built on spots that have flooded continually in the past. With expensive buildings, furnishings, valuable goods and records, high-rise apartments, and homes being added every year, damage to property climbs to billions of dollars.

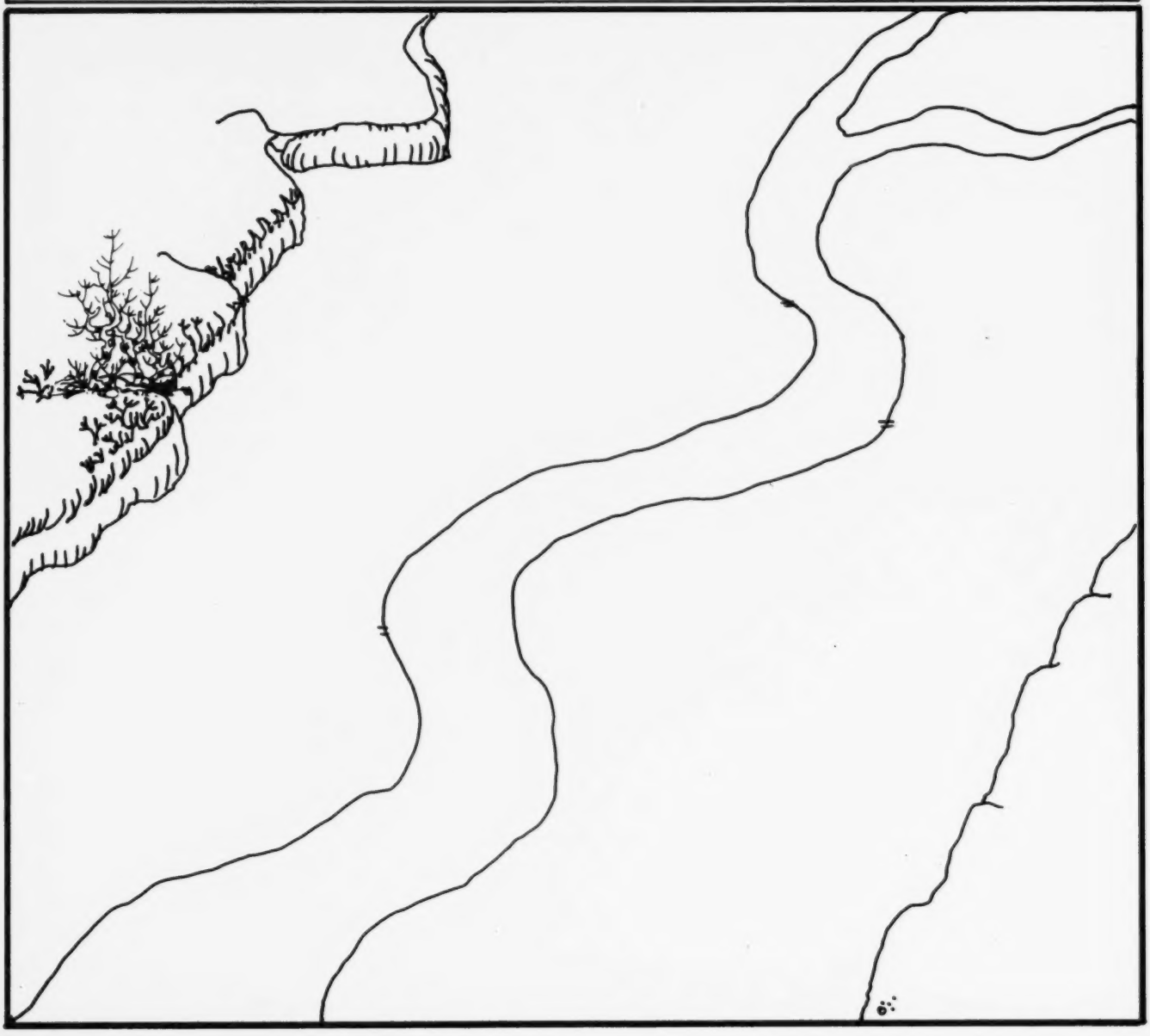
By paving more and more areas in cities along the floodplain, the damage from each flood also increases. There is less soil and vegetation to absorb the runoff and overflow. Asphalt and concrete pile high with water that has no where to go. The problem mounts with each new city.

Name _____

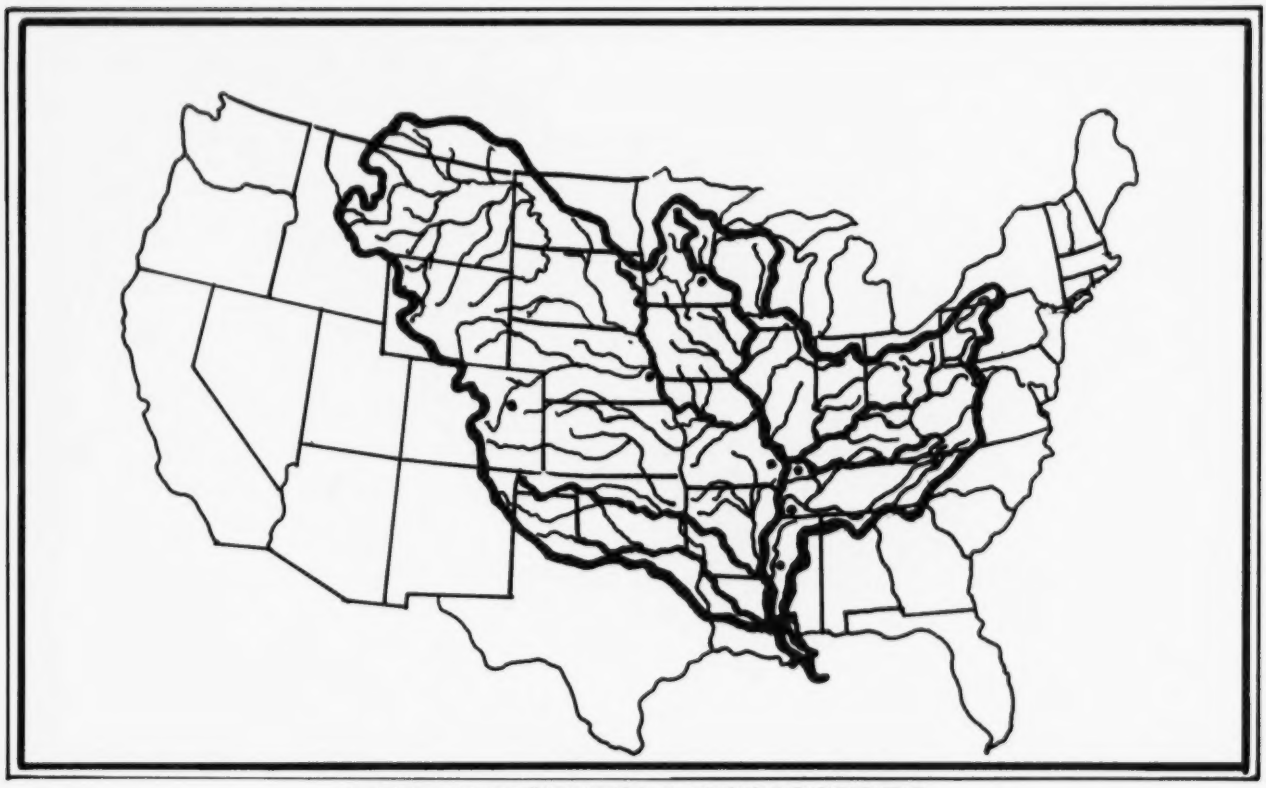
ONE POSSIBLE SOLUTION

It seems inevitable that people are going to continue to live along floodplains. Flood warning systems and good flood safety rules help save lives during severe flooding. What else can people do to protect themselves and their property from the inevitable flooding that will occur in floodplain communities? Devise some possible solutions to this age-old problem. Think about it. Draw your plan on the floodplain below. Write about your proposal on a sheet of notebook paper.

Read to find out about flood protection plans that people have tried in the past. The ancient city of Mohenjo-Daro, for example, was slowly overun by mud from a lake. Year after year, the people added top floors to their homes as layers of mud filled the bottom floors. Archaeologists have found parts of the buildings forty feet below the surface of the mud.



Name _____



THE MIGHTY MISSISSIPPI

The Mississippi River has one of the longest river systems in the world. It flows from Lake Itasca in northern Minnesota, near the Canadian border, 2350 miles southward to the Gulf of Mexico below New Orleans, Louisiana.

Water from nearly 100,000 streams in one quarter million square miles of land empties into the Mighty Mississippi. Only the Amazon and Congo rivers drain more miles of land. Thirty-one states and two Canadian provinces feed the Mississippi almost from coast to coast. Two major rivers, the 2530-mile-long Missouri River and the massive Ohio River, flow into the Mississippi at Alton and Cairo, Illinois. The emptying of these two rivers causes the lower Mississippi (below Cape Girardeau, Missouri) to have more flood and river control problems than the upper river.

SEE IF YOU CAN FIND OUT

1. Do you live in an area drained by the Mississippi River? Can you follow the path of water on a large map from your community to the Mississippi? See if you can find maps that show the streams, lakes, and rivers in your area. Can you make a topographical map that shows the Mississippi drainage basin?
2. Find out how one of the major cities along the Mississippi prospered as a result of its location. Tell about the founding of the city and its growth. What is the city like today? Does it still depend on the Mississippi? How?
3. Read about the Continental Divide. Find out where the other areas of the United States drain into the sea.
4. Color the Mississippi and its tributaries blue. Color the area drained by the Mississippi River green. Color the rest of the United States a color of your choice.

Name _____

In a crumbled, hurried note to his young wife, a Confederate soldier in Natchez, Mississippi, reflected on the gentle waters of the Mississippi.

"It's a peaceable, lazy Old Man," he wrote. "And it flows with a long, low grace."

Years later, a Mississippi planter was caught in the terrible flood of 1927 near the same spot, but what he saw was ". . . a tan-colored wall seven feet high, and with a roar as a mighty wind. . ." as the rampaging river rushed toward him.

The famous American writer, Mark Twain, once wrote that no matter how hard people tried to contain the Mississippi, they "cannot tame that lawless stream, cannot curb it or confine it, cannot say to it, 'Go here or go there,' and make it obey."

Read the following article to find out how people have tried to control the Mighty Mississippi as they settled to build along its shore.

FLOODING ALONG THE MISSISSIPPI

Even the first European settlers that arrived at the Mississippi understood its tremendous power and awesome majesty. Hernando De Soto's men recorded stories of Indian homes high on the bluffs above the flooding river and Indian mounds raised as protection from floods. When the French were told to build a city called Nouvelle Orleans at the Mississippi delta, they wrote to say it would be too dangerous because of floods. Nevertheless, throughout the 1800's people began to settle along the river. Its soil was rich enough to feed a growing nation, and its waters could carry goods and passengers with speed and ease to newly developing American communities.

Each river town worked to improve navigation along the Mighty Mississippi. Levees were built to hold some of the seasonal floodwaters away from families and farms. Levees are huge dirt banks that stop the water and direct it elsewhere. The weight and movement of the Mississippi eroded the levees. Pigs rooted through them, and muskrats and crayfish dug tunnels that caused leakage. Still, people repaired the levees constantly, and continued to build more.

1. A man-made levee is
   a. a small crayfish that digs through the banks of rivers.
   b. a dirt bank that holds water from farmlands and directs it elsewhere.
   c. a large raft that floated along the Mississippi.
2. Levees were damaged by
   a. soldiers in the Confederate War.
   b. Indians who didn't want settlers in the area.
   c. erosion and river animals.
3. From the article, it is easy to see that
   a. no one recognized the power of the Mississippi.
   b. even the earliest settlers recognized the power of the Mississippi.
   c. farmers realized they couldn't control the Mississippi.

Name _____

A TAN-COLORED WALL SEVEN FEET HIGH

After a terrible flood in 1849, Congress asked the Army Corps of Engineers to look at flood control along the Mississippi. They coordinated levee districts, standards, and regulations. The river continued to flood.

With each new city built on the floodplain, new disasters were recorded as the cities flooded. After a particularly catastrophic flood in the first decade of the twentieth century, the Federal Government set up the Mississippi River Commission in 1917. With major additions that cost millions of dollars, the system of levees and dikes was greatly improved. Then disaster struck again.

Heavy rains pelted the nation from the Dakotas to the Ohio valley in the summer of 1926. Tributaries like the Cumberland and the Ohio recorded water levels 40 feet higher than previous years. Through the winter, the rivers crested at record levels, and the rains continued. Sandbags were piled on levees for extra strength. The rushing water from the upper river tore at the levee called Mound Landing at a bend just north of Greenville, Mississippi. Finally it could hold no longer. A mighty wall of water roared over the levee and flooded more than two million acres. Raging tides flowed back up the tributaries south of Greenville causing new misery as town after town was swallowed by the deluge.

1. The Mississippi River Commission was established to
   a. govern the new state of Mississippi.
   b. study and strengthen the levees along the Mississippi floodplain.
   c. prevent flooding on the Mississippi ever again.
2. Mound Landing gave way to the flooding river because
   a. it was weaker than the other levees.
   b. it was older than the other levees.
   c. it was located at a bend in the river, so it received the full impact of the rushing waters.
3. The "tan-colored wall seven feet high" referred to
   a. the crest of the flooding Mississippi as it broke through the levee.
   b. the levee at Mound Landing.
   c. the bluff overlooking the Mississippi at Memphis.

Name _____

NEW PLANS FOR THE RIVER

Thousands of people were marooned along bluffs and levees as the Mississippi gathered speed and volume heading for the Gulf of Mexico. When the Atchafalaya River Basin in Louisiana was flooded, people knew that New Orleans would probably be next. It was a large city right at the final bend in the Mississippi. The levees above it would never hold back the swollen river.

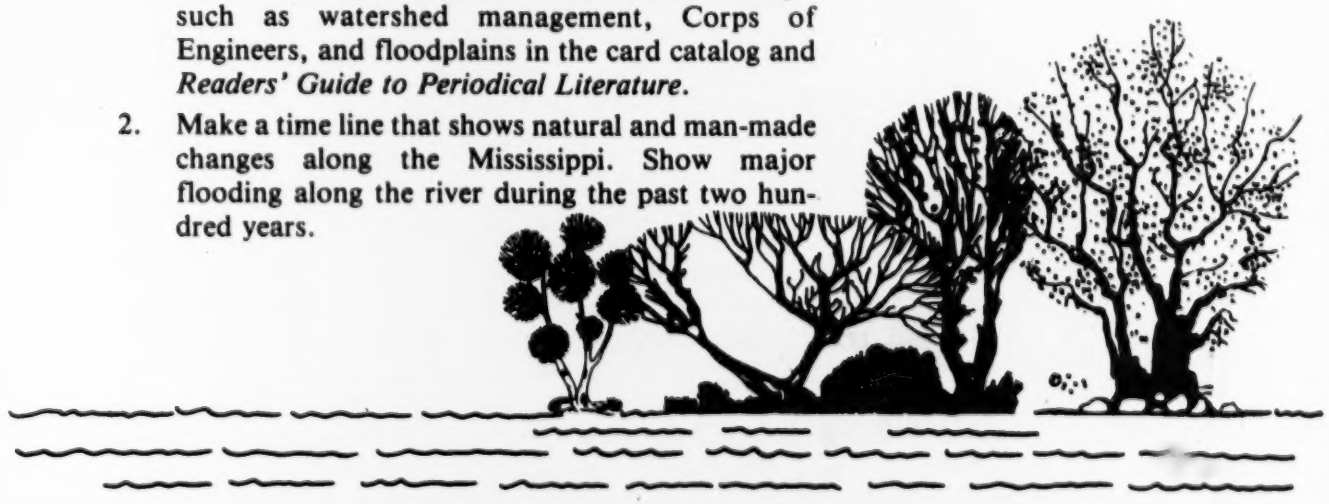
Government officials from Louisiana worked with engineers to devise a desperate plan. They decided to purposely destroy a levee at Caernarvon so the raging waters could head southeast into the Gulf, and spare the people of New Orleans. With great difficulty, dynamite was set deep into the brown, murky waters at the base of the levee. Dozens of bayou families were evacuated from the path, and the levee was blown apart.

Like civilizations long ago, the people along the Mississippi River had discovered that levees alone could not possibly contain a mighty river. Three hundred people died in the 1917 flood, thousands were missing, and hundreds of thousands were homeless. New flood control measures would have to be tried.

The Flood Control Act of 1928 was approved by Congress. The Mississippi River became a national responsibility. Artificial cutoffs were made between winding loops in the Mississippi. Revetments were devised to decrease erosion along the banks of the river. Waterways were completed which would allow overflow to lakes and safe acreage. The Bonnet Carré Spillway was constructed to protect New Orleans by pouring floodwater into Lake Pontchartrain. The Atchafalaya Basin Floodway projects began. A major flood in 1973 caused less damage and far less loss of life as a result of flood control measures on the Mississippi.

Hydrologists know that the Mississippi, like all rivers, alters its course over the centuries. Some people believe the river will ultimately adopt a route to the sea through the Atchafalaya River. New Orleans and Baton Rouge will be tragically affected if they are right. Time and the river will tell.

1. **Read to find out** more about the Mississippi and other flood control plans. Look under headings, such as watershed management, Corps of Engineers, and floodplains in the card catalog and *Readers' Guide to Periodical Literature*.
2. Make a time line that shows natural and man-made changes along the Mississippi. Show major flooding along the river during the past two hundred years.



Name _____

JUST KEEPS ROLLING ALONG

Mark Twain is a famous American author who loved the land and the people along the floodplains of the Mississippi River. When you read the adventures of Tom Sawyer, Becky Thatcher, Injun Joe, and Huck Finn, you understand more about the communities that flourished along the river in the nineteenth century.

Read to Find Out

1. How did Mark Twain get his name? How did Old Man River get its name?
2. What famous American composer often wrote about the Mississippi River?
3. What other rivers around the world have become famous in story and song?
4. Try this investigation from *The Whole Cosmos Catalog of Science Activities*. Get a big bowl of water (a bathtub or sink will do) and several one-ounce balls of Play-Doh. See which of your friends can get her clay ball to float. Which shape floats best? Whose floater can hold the most weight (marbles work nicely for cargo) and still stay afloat? What might this investigation tell you about the huge vessels that carry goods on the Mississippi and other major rivers of the world?

5. Read about the paddle wheel pilots that navigated the Mississippi River a hundred years ago.
   a. Imagine a day in the life of a riverboat captain. What kind of people might he meet during his day? What kind of job would he have? You might want to write about his day as though it were a ship's log or a personal diary.
   b. How do you suppose riverboat navigation has changed since Mark Twain's Day? What new inventions have helped change transportation along the Mississippi River? Read to find out more about the Mississippi today.
   c. Find out about job opportunities on the river today. You can write for information to the Mississippi Museum, Mud Island, Memphis, Tennessee 38112.

Name _____

ONE-HUNDRED-YEAR FLOODS

While cities on the floodplains continue to wrestle with the problems of seasonal and flash floods, future generations can wisely choose not to settle in areas that are sure to flood. Unfortunately, the likelihood of floods happening in a particular place is often overlooked by land developers, home buyers, and vacationing campers. Warnings are available, however, and careful attention to current data could save countless lives and untold human misery every year.

The U.S. Geological Survey and the Army Corps of Engineers publish maps and reports showing areas along waterways that are potentially dangerous. They rate flood danger by combining the history of floods in a particular region with the changing natural and man-made structure of the area. A 10-year flood, for example, is one of size and severity that might happen once every ten years in that specific place. A 100-year-old flood has a one-in-one hundred chance of happening in any given year. Of course, flooding in that spot could happen much more often.

The Mississippi River has had four 100-year floods already this century! In August, 1952, Lynmouth, England, had a 50,000-year flood. Good sense tells us it is wiser not to build, settle, or set up camp in highly flood prone areas.

1. The U.S. Geological Survey publishes maps and reports showing areas that are likely to flood so that
   a. people can avoid settling in these areas.
   b. the areas will eventually stop flooding.
   c. the Army Corps of Engineers can control the floods.
2. The Lynmouth, England, flood in 1952 probably
   a. was not a very big flood.
   b. will happen again very soon.
   c. was very unexpected and severe.
3. If a family builds a home on a 10-year flood site, it should expect
   a. never to be flooded out.
   b. a major flood might easily damage their home.
   c. ten years of safety from floods.

Name _____

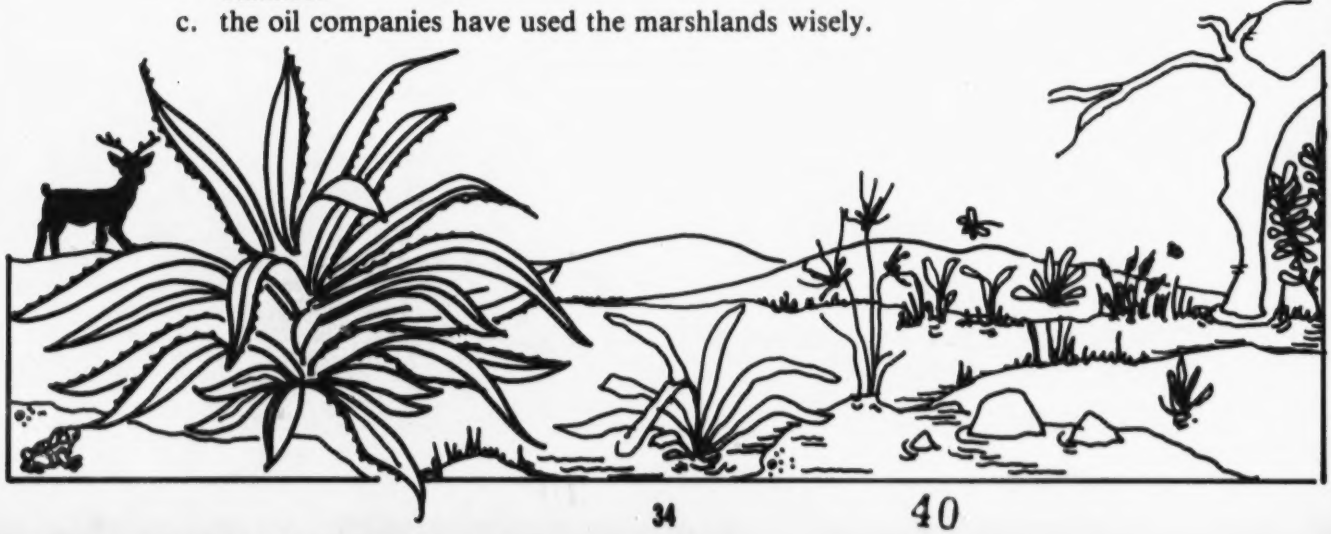
LOUISIANA'S VANISHING WETLANDS

At the Mississippi River delta, Louisiana has almost half of the coastal wetlands in the United States. For 7000 years, the marshes have been growing steadily rich in plant and wildlife abundance. The five million acres supplies almost a third of the seafood produced in this country. These same barrier islands have helped protect the coastline from dangerous flooding during hurricanes.

Today, an acre of Louisiana marshland—along with its delicate ecological system of plant and animal life—disappears every sixteen minutes! Scientists predict that all the land south of New Orleans will have returned to the sea within the next fifty years, and the rate of loss is increasing every year.

Man-made levees interfere with the natural deposit of silt from which the delta marshes grow. Twelve thousand miles of oil field canals cut through the Louisiana wetlands. During the past fifty years, these channels have allowed salt water to overrun freshwater marshes and destroy plant life. Thousands of oil service boats travel the canals daily, leaving toxic substances and wastes which further eat away at the bayou marshes. Dredging and filled areas block the natural passage of water. Wildlife species disappear with the wetland areas, an irreversible tragedy.

1. Acres of marshland are disappearing because
   a. animals are eating the wetland grasses.
   b. levees and oil field canals have disrupted the natural ecological balance.
   c. the sea is changing in the Gulf of Mexico.
2. In fifty years, the communities along the Louisiana coastline might
   a. easily be devastated by hurricane floods.
   b. have plenty of shrimp as they move inland.
   c. welcome tourists to their colorful barrier islands.
3. From the information in this article, you can tell that
   a. coastal areas are difficult to maintain.
   b. careless use of natural resources can cause tragic damage to our ecological balance.
   c. the oil companies have used the marshlands wisely.



Name _____

CHANGE BEGINS WITH KNOWLEDGE AND CHOICE

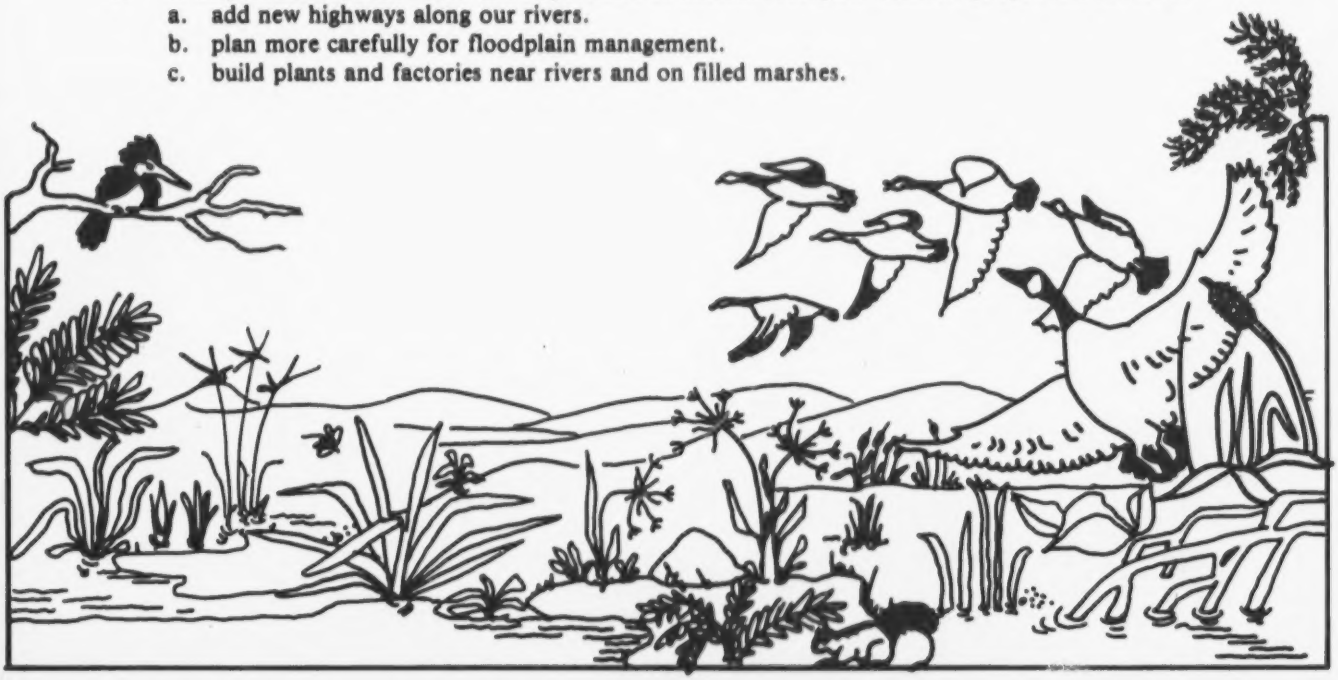
Every day, more people are choosing to work toward a lifestyle in harmony with nature. Change begins with knowledge. As individuals learn about the delicate interrelationships in the earth's ecosystem, they understand the importance of maintaining or returning to natural ecological balance.

People can be most effective in working for change if they read to find out about wetland conservation and floodplain management. It is important to have a firm base of information about what can be done, what has been done, and how alternate plans have succeeded.

Marshlands and floodplain forests are not just beautiful to see, they are a vital link in water management. Trees, green leaves, and ground cover divert water before it reaches the ground. Some evaporates or is absorbed by neighboring vegetation. Soil that has been aerated by worms, insects and burrowing creatures can absorb more water. Tree roots and fine plant roots also take in water and leave open spaces in the soil for water to seep further underground. Meanwhile, food chains thrive for wildlife species, domestic animals, and people themselves.

Marshes, farm ponds, stream bottoms, estuaries, swamps, and prairie potholes are all wetland areas. Concrete and canals and committees are ruining more of these vital areas every day. It is possible to save our wetlands only if people are willing to work towards that goal **today.**

1. Flooding from runoff increases when the ground is covered with
   a. pavement.
   b. grasses.
   c. trees and plants.
2. Wetland plants and wildlife play an important role in flood control by
   a. becoming part of the food chain.
   b. measuring rainfall.
   c. letting water seep into the ground more effectively after being diverted by vegetation and aeration.
3. If they understand the value and importance of natural ecological balance, people can **choose** to
   a. add new highways along our rivers.
   b. plan more carefully for floodplain management.
   c. build plants and factories near rivers and on filled marshes.



Name _____

SAVING OUR WETLANDS

Quality instead of quantity might become one important goal for our future. Change begins with public awareness of the importance of maintaining or returning to a natural ecological balance. Many technologies and dedicated private organizations, as well as government agencies, are working toward this goal.

The Atchafalaya Basin is the largest river overflow wetland in the United States. Many dedicated people have worked for the past decade to perserve the huge hardwood swamps and unique wildlife heritage in this area. Unfortunately, no one agrees on basic goals for the Louisiana Basin. Landowners, legislators, conservationists, engineers, and hydrologists are still working on its future.

In Florida, agricultural and city development has almost cut the **Everglades Swamp** in half. Now people are working to undo some of the damage that giant man-made canals have caused along the Kissimmee River. The plan will restore some of the wetland areas, and is a big step towards understanding our need to live in harmony with nature.

The **Watershed Management Program** for Four Mile Run in northern Virginia was the first urban project of its kind. People looked at an overall plan for flood walls, canals, levees, and natural areas that would help control runoff in heavily paved city areas.

What can you do today to make changes that will affect natural resources in your area tomorrow? Start by making a list of what you know about the value of wetland areas, what is happening to them now, and what can be done about saving them.

1. Progress in preserving the Atchafalaya Basin is taking a long time because
   a. no one cares about the swamp.
   b. people have just started to think about the wetlands.
   c. decision makers are having difficulty deciding on basic goals for the swamp.
2. Quality instead of quantity refers to
   a. the way we work with our natural resources.
   b. buying items in large bulk.
   c. the price of goods and materials.
3. You can tell from this article that people are beginning to
   a. use more natural resources carelessly.
   b. make changes to restore the ecological balance in our floodplain areas.
   c. forget that natural resources are vital to the health and welfare of our nation.

Name _____

WORKING FOR ENVIRONMENTAL CHANGES

You have been learning about environmental problems caused by misuse of floodplains and wetlands. You have been gathering information from agencies, government officials, newspapers, books, environmental groups, and magazines. You can add to your understanding of the problem by inviting local businessmen and people in your community to present their views to your class.

It is important to study all sides of the problem before you decide to actively work for change. When you planned your flood safety campaign, it was easy to see exactly what people should do to protect themselves in a flood emergency. Restoring ecological balance in a technological world is more complicated.

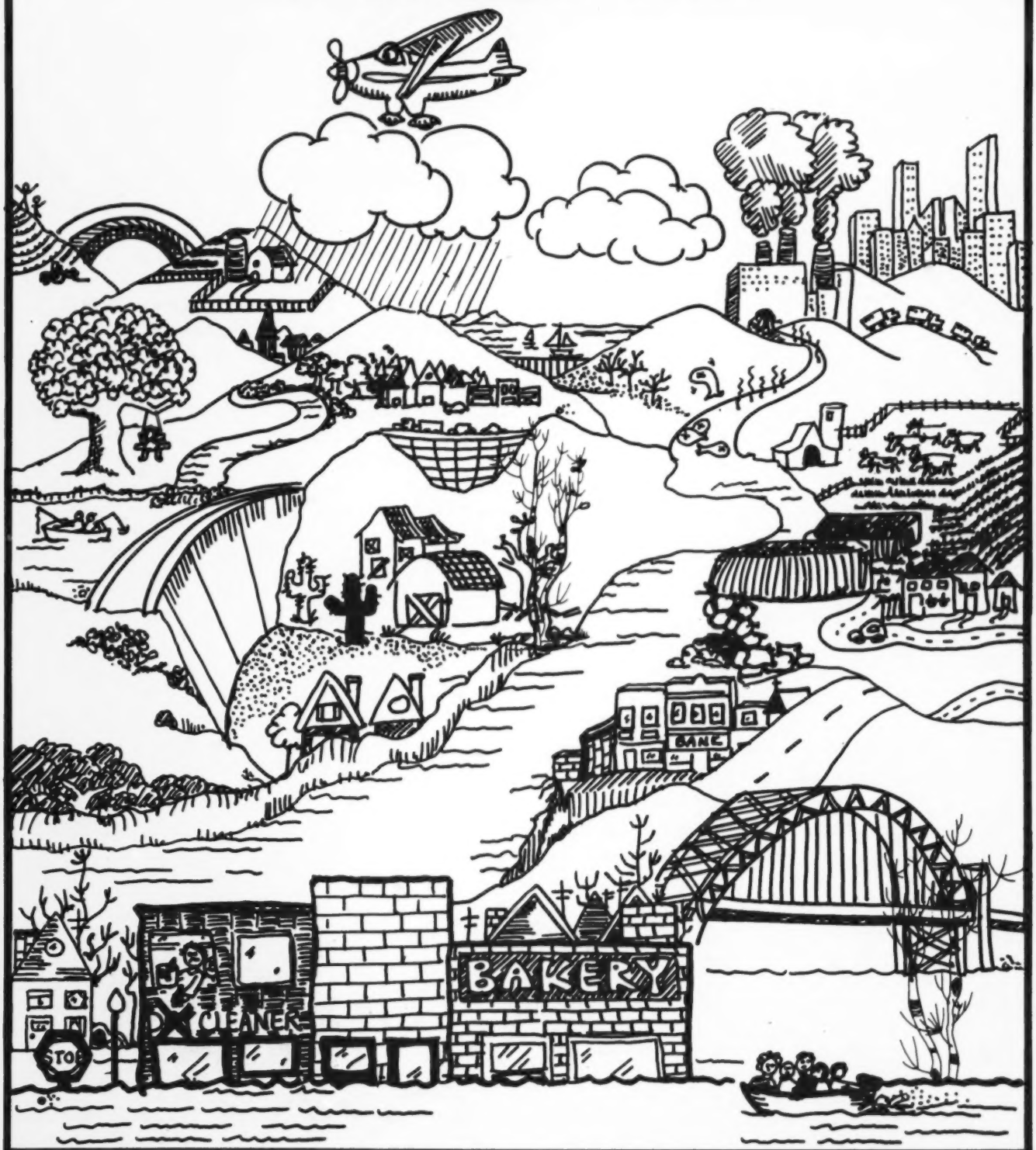
Listen to people who agree with your view of the problem, and listen to those who disagree with you. Talk with people who are experts in the field, and talk with people who have real questions about the issues. Think about who is being affected by the problem and who will be affected by the solution. Don't be discouraged when you find many different viewpoints. You can learn something new from each perspective.

Working towards change takes a real commitment. Just by asking questions and making people aware of the problem, you are helping to bring about change! If you decide to take further action, get together with people who feel the same way you do. Brainstorm ways you can make things happen. Encourage each other. Think of many different ways to state your problem. Consider the most effective ways of communicating with specific groups of people. You would certainly present the problem and possible solutions in one way to a group of third graders and in another way to a board of government officials.

Keep a list of new ideas and new information about water management in your *Floods & Droughts* notebook. When something that someone says brings an idea into focus for you, jot down exactly what was said. Think about it later. Elaborate on your ideas.

Don't give up! What you do is very important to the way we all live tomorrow! The activities on the next two pages might help you begin to put together some of the information you have been learning about floods and droughts.

COMMUNITIES IN DANGER



Look at how water is being used in this picture. Circle ways that people have changed the natural flow of water. Find people who benefit from water, and people who are left without water or who are in danger from too much water. Talk about use and misuse. How are some parts of the community affected by the water rights of others far away? What legal rights do you think communities should have? Who should decide water rights?

SCARCITY! A SIMULATION OF WATER SHORTAGE SURVIVAL PLANS

A Midwestern community has experienced a very dry year. Spring and summer are ahead, and the forecasts show little rain to replenish the dwindling water supply provided by its river and reservoir. Of 1000 units of water available, each interest group must decide how much it should be allotted to meet minimal needs.

Divide the class into eight groups, each with a simulation card. After sufficient individual discussion time, each group selects a representative to defend its water rights to the class. Students may negotiate for water rights after hearing the needs assessments, or they may choose a panel to decide on final allotments. They must agree to accept or reject recommendations through a class vote.

Town Council. Your people need water for their homes and businesses. List your needs for _____ units.	**Homeowners' Association.** Your subdivision has almost 200 homes. People have invested a lot of money in gardens and grass seed for their new property. You need _____ units.
Board of Trustees for Hydroelectric Plant. If you are not able to get _____ units for making electricity, electric service will be drastically reduced and very expensive.	**Fish and Wildlife Service.** Without water in the streams and wetlands, many species may die out altogether. Others will suffer tremendous hardships. You need _____ units.
Farmers' Association. You need more water than ever to feed cattle and produce crops. Your farms serve the canning company that employs 1/3 of the townspeople. _____ units.	**Administrators of a Nuclear Power Plant** that hope to locate in your town and employ hundreds of people. The city will grow in wealth and quality of life with _____ units.
Board of Directors of the Manufacturing Company that employs more than half the city's people. Without large quantities of water, you will have to close down. You need _____ units.	**Wild and Scenic River Commission.** Hundreds of nature lovers relax with your townspeople at the river every year. They can bring business and friends to the city with _____ units.

Always evaluate the process and the outcomes of a simulation game with the entire class. Ask students to rate the effectiveness of their original discussions, their negotiations, reconsiderations, and consensus. How do you think real communities solve similar problems?

WHERE TO FIND OUT MORE

Students have an opportunity to review information from a variety of perspectives if they take advantage of the free material offered by the following organizations and agencies about floods and droughts. It's exciting to get mail, and sometimes a personal letter, from people who are concerned about the same issues they are studying. If students write letters **before** the unit gets into full swing, the information becomes a real learning and enrichment tool.

Encourage students to create an original logo or heading for their stationery, or use the letter form on page 42 to get them started.

American Association of State Climatologists
c/o Bernard E. Dethier, Cornell University
Ithaca, New York 14850

American Fisheries Society
1040 Washington Building
Washington, D.C. 20005

American Meteorological Society
45 Beacon Street
Boston, Massachusetts 02108

American Forestry Association
919 Seventeeth Street, N.W.
Washington, D.C. 20006

American Forest Products Industries, Inc.
1835 K Street N.W.
Washington, D.C. 20006

Bureau of Reclamation
Department of the Interior
Washington, D.C. 20240

Canadian Meteorological and Oceanographic Society
151 Slater Street
Ottawa, Ontario, Canada

Conservation Foundation
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

Council on Environmental Quality
722 Jackson Place
Washington, D.C. 20006

Department of Energy
1000 Independence Avenue S.W.
Washington, D.C. 20585

Environmental Data and Info Services/NOAA
8621 Fenway Road
Bethesda, Maryland 20034

Environmental Defense Fund
P.O. Drawer 740
Stony Brook, New York 11790

Fish and Wildlife Service
U.S. Department of Interior
Washington, D.C. 20240

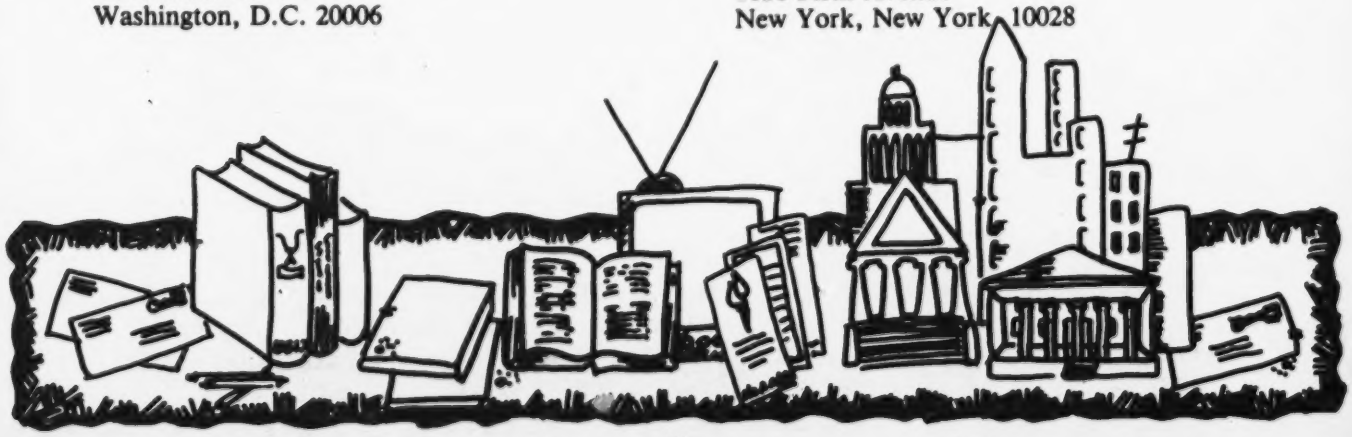
Federal Emergency Management Agency
1725 I Street
Washington, D.C. 20472

Friends of the Earth
30 East 42nd Street
New York, New York 10017

Geological Survey
Department of the Interior
Reston, Virginia 22092

Information Office
U.S. Department of Agriculture
Washington, D.C. 20250

National Audubon Society
1130 Fifth Avenue
New York, New York 10028



WHERE TO FIND OUT MORE

National Council of Industrial Meteorologists
c/o Don Packnett, P.O. Box 5888
Denver, Colorado 80217

National Climatic Center
Federal Building
Asheville, North Carolina 28801

National Earth Satellite Service/NOAA
Washington, D.C. 20233

National Geographic Society
17th and M Streets, N.W.
Washington, D.C. 20036

National Hurricane Center/NOAA
1320 Dixie Highway
Coral Gables, Florida 33146

National Oceanic and Atmospheric Administration
Department of Commerce
Washington, D.C. 20230

- Flash Floods NOAA/PA 73018
- Weather and Flood Hazard Catalog NOAA/PA 82003
- Thunderstorm NOAA/PA 75009
- Flash Floods NOAA/PA 77014
- Local Storms NOAA/PA 70012
- Floods and Warnings NOAA/PA 81010
- Owlie Skywarn Poster NOAA/PA 77016
- Tsunami Watch and Warning NOAA/PA 74301

National Center for Atmospheric Research
P.O. Box 3000
Boulder, Colorado 80307

National Parks Association
Washington, D.C. 20009

National Severe Storms Laboratory
1313 Halley Circle
Norman, Oklahoma 73069

National Severe Storms Forecast Center /NOAA
Federal Building
Kansas, City, Missouri 64106

National Weather Service
6121 Wayside Drive
Rockville, Maryland 20852

National Weather Association
4400 Stamp Road
Temple Hills, Maryland 20748

National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036

State Conservationist of the
Soil Conservation Service
U.S. Department of Agriculture
Washington, D.C. 20250

State Department of Conservation
Conservation Education
1516 9th Street
Sacramento, California 95814

U.S. Chamber of Commerce
National Resources Department
1614 H Street
Washington, D.C. 20006

Water Resources Council
2120 L Street
Washington, D.C. 20037

Weather Modification Association
P.O. Box 8116
Fresno, California 93727

Weekly Weather and Crop Bulletin
U.S. Department of Agriculture
Washington, D.C. 20250

Weatherwise
Heldref Publications
4000 Albemarle St. NW
Washington, D.C. 20016

The Wilderness Society
729 Fifteenth Street, N.W.
Washington, D.C. 20005

48

GLOSSARY

alluvial (ah LOO ve uhl): rich soil deposited by rivers and streams

archaeologist: scientist who studies excavated, prehistoric cultures

barrier islands: coastal islands, swamplands, and marshes

basin (BAY sin): the area drained by a river

canal: tubelike passageway: artificial waterway

channel: the bed of a stream or river

catastrophe (cah TASS troh fee): a great disaster

condensation (kahn den SAY shun): transformation of water from vapor into liquid

crest: the top or highest point

current: water moving in one direction

dam: barrier to obstruct water

delta: triangular area between branches of a river mouth

deluge (DELL ooje): a great flood

drought (drowt): a period during which there is not enough water to sustain life in a particular area as it is normally sustained

El Niño (el NEEN yo): weather changes that follow the heating of the oceans at the equator

erosion: the carrying away of rocks and soil by wind and water

evaporation (ee vap ah RAY shun): the change of water into vapor or gas

flash flood: rapidly moving, high water that comes without warning as a result of natural and man-made drainage systems overflowing with heavy rains or snow melts

flash flood watch: flash flooding is possible in the designated area

flash flood warning: a flash flood is in the immediate area or expected to happen instantly

floodplain: a strip of flat land bordering a stream or river, consisting of sediment laid down over the centuries by the river as it moves within the valley walls

fronts: the places where cold and warm air masses meet

geologist (jee AHL oh jist): a scientist who studies rocks and other features of the earth's surface

habitat: the place where a thing lives within a community

hurricane: a storm that forms over warm oceans near the equator

hydrologic (hy droh LAH jik) cycle: the water cycle of evaporation, condensation and precipitation by which water is constantly purified and recycled

hydrologist (hy DRALL uh jist): a scientist who studies the movement of water on the earth's surface, in the atmosphere and beneath the surface of the earth

levee (LEH vee): natural or man-made bluff that holds water within its floodplain

limnology (lim NAHL oh jee): the study of freshwater lakes, rivers, and seas

marshlands: low wetlands, swamplands

meteorologist (mee tee or AHL uh jist): a scientist who studies the weather

National Oceanic and Atmospheric Administration: that part of the Department of Commerce that studies the nation's rivers and coastlines (NOAA)

National Weather Service: part of the NOAA that is directly considered with weather forecasts and issuing weather conditions and forecasts through NOAA Weather Radio

precipitation (prih sip uh TAY shun): moisture that falls from the sky

predict: to forecast on the basis of observations or past experience

reservoir: a place where water is stored for use

revetment: the shoring up of the banks of a river through man-made devises meant to reduce erosion

rills: small brooks

River Forecast Centers: agencies across the United States that watch water flow and water level conditions in order to forecast flood stages

silt: soft earth carried and deposited by a river or stream, sediment

slag: refuse materials produced by mining for ore

spillway: overflow passageway

torrential: rapidly, violently moving water

tsunami (soo NAH mee): a tidal wave caused by earthquakes under the ocean

wetlands: swamps, stream beds, marshlands, and prairie potholes where water is naturally absorbed in seasonal flooding

READ TO FIND OUT

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Battab, Louis J. *Weather in Your Life.* New York: W.H. Freeman and Company, 1983.

Brown, Walter R., and Billye W. Cutchen. *Historical Catastrophes: Floods.* Addison-Wesley, 1975.

Canby, Thomas Y. "El Niño: Global Weather Disaster," *National Geographic,* February, 1984.

Clark, Champ. *Flood.* Time-Life Books, 1982.

Fodor, R.V. *Angry Waters: Floods and Their Control.* New York: Dodd, Mead and Company, 1980.

Ganzel, Bill. *Dust Bowl Descent.* University of Nebraska Press, 1984.

Leopold, Luna and Kenneth S. Davis. *Water.* Time-Life Books, 1966.

Thompson, Philip D., and Robert O'Brien. *Weather.* Time-Life Books, 1965.

ANSWER KEY

p. 3 1. b 2. b 3. a
p. 4 1. b 2. b 3. a
p. 5 1. b 2. b
p. 6 1. b 2. a 3. a
p. 8 1. c 2. c 3. b
p.10 1. c 2. a 3. b
p.11 1. a 2. b 3. a
p.12 1. b 2. a 3. b
p.13 2. c 3. a
p.16 1. c 2. a 3. b
p.17 1. a 2. a 3. c
p.19 1. c 2. b 3. a
p.20 1. c 2. c 3. a
p.29 1. b 2. c 3. b
p.30 1. b 2. c 3. a
p.33 1. a 2. c 3. b
p.34 1. b 2. a 3. b
p.35 1. a 2. c 3. b
p.36 1. c 2. a 3. b

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